CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION FOR FORAMINIFERAL RESEARCH

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Contents

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION FOR FORAMINIFERAL RESEARCH

Editor

Frances L. Parker

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ALICE ELEANOR CUSHMAN

1907 - 1957

In her relatively short lifetime Alice Cushman contributed immeasurably to her illustrious father's life work. From her early youth the Laboratory was the center and ruling influence of her every-day life, and she was surely its most devoted servant.

Alice Cushman, second child of Joseph Augustine Cushman and Alice Edna Wilson, was born June 18, 1907, in her maternal grandparents' home in Fall River, Massachusetts. Somewhat over a year after her mother's death when Alice was not yet 5, the family moved into the newly built house at 76 Brook Road in Sharon, Massachusetts. This remained Alice's only home throughout her life. It was then at the extreme end of the street and she liked to recount the experiences of the early years, before nearby neighbors moved in, when unploughed winter storms necessitated the bringing of food and mail in by sled over the snow.

Nearly ten years of elementary and secondary schooling elapsed for Alice, during which the direction of her father's career had gradually changed from Museum Director to consulting geologist and finally virtual retirement into pure research. Then, on a Friday afternoon as Alice recalled it, her parents, having just returned from Mexico where Dr. Cushman had been engaged in consulting work for the Marland Oil Company, called for her at the high school and told her of their plans. A Laboratory would be built down at the far edge of the orchard—the plans had already been sketched out on the train en route home—and Dr. Cushman would continue his consulting work from there. Alice would transfer from high school to business college to prepare for the task of being her father's secretary. And so it was. The following Monday (which was the second of April 1923, a date always celebrated as the founding of the Laboratory) the contractors began the work of constructing the building, and Alice entered a business college in Boston. Her term there, though brief, gave her secretarial training in which she became very proficient. Thus at the age of 16 she became Secretary of the Cushman Laboratory for Foraminiferal Research.

Though only a distance of a few hundred yards from the house, the Laboratory was a place of serious business and soon became a mecca for visitors and students. A succession of various townspeople in Sharon found employment there from time to time. In all these Alice took great interest, though because of her shyness and reserve she made few close friends among them.

Her work involved a great variety of tasks. Strangely, she never wished to have anything to do with the specimens themselves, and so never worked with a microscope. Many mounted slides, however, bear her minute and meticulous labeling. Likewise, in many catalog books her clear handwriting is to be seen. All proof-reading was left to her careful scrutiny. She handled her father's correspondence, filing, and the thousand and one details of subscription orders and payments, thereby providing him with unnumbered additional hours for research.

In the late 1930's and early 1940's, when the Laboratory annually transferred activities to its temporary summer quarters in the White Mountains of New Hampshire, Alice continued her work there, interspersed with occasional walks and climbs in the nearby hills. Wherever she was, Alice was a remarkably keen observer, frequently pointing out some rare plant, curious stone, or faintly heard bird song. It seemed she observed the natural world almost in the same unhurried meticulous way that she read proof, in order to overlook nothing. Her quiet but deep appreciation of the natural world found expression in poetry. She kept exact and detailed notes on everyday happenings connected with the Laboratory from its beginning, records which were often found to be of use as well as of interest. She was endowed with an exceptionally keen mathematical mind; intense concentration was characteristic of her.

She contributed large sums for the publishing of several of the earlier "Special Publications" and her personal charities were many and generous.

At her father's death his remaining publications were left to her. When the scientific contents of the Laboratory were moved to the Smithsonian Institution in 1950, Alice moved the publications from the Laboratory building into one of the garages near the house, set up her office in the house, and proceeded to continue their sale. In her will she provided that the Cushman Foundation should receive the still remaining publications.

Thus through her world-wide correspondence many people came to know Alice—probably many more than she herself realized. Her sudden and unexpected death, on October 9, 1957, brought to an end her quiet and beneficient career.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION FOR FORAMINIFERAL RESEARCH

VOLUME IX, PART 1, JANUARY, 1958

176. *FEURTILLIA FREQUENS*, N. GEN., N. SP., A NEW GENUS OF LITUOLID FORAMINIFERA

WOLF MAYNC

Compagnie d'Exploration Pétrolière, Chambourcy (S. & O.), France

ABSTRACT

A new lituolid genus, for which the name **Feurtillia**, n. gen., is herewith proposed (with **Feurtillia frequens**, n. sp., as type species), occurs frequently in some samples from the Purbeckian and Valanginian of the Swiss Jura Mountains. It is a small **Ammobaculites-** or **Ammomarginulina-**like form which is characterized by the presence of a delicate sub-epidermal network similar to that of **Choffatella** and other choffatelline genera. **Feurtillia** differs from any genus of that group by its compact septa and by its simple aperture (vertical slit).

INTRODUCTION

During the writer's present study on some genera of the Choffatellinae, n. subfam.[1] (Lituolidae endowed with a well-developed sub-epidermal meshwork), hundreds of small excellently preserved Foraminifera were observed in the washed residues of some surface samples, collected in the Purbeckian and Valanginian of the Swiss Jura Mountains by Dr. F. Burri, Basel, who kindly gave permission that the writer's results be published.

These samples had previously been studied by H. Bartenstein, Celle-Hannover (Bartenstein & Burri, 1954; Burri, 1957).

During a short visit at the office of the Socony Mobil Oil A. G., Celle, the writer had the opportunity to examine the available material and he also obtained comparative specimens. For the valuable assistance in this respect, the author herewith expresses his sincere appreciation to Socony Mobil Oil A. G., especially to Dr. H. Bartenstein.

1 Our investigation, based on original material as well as on numerous topotype specimens, has shown that the upper Jurassic and Lower Cretaceous forms **Spirocyclina lusitanica** (Choffat) and **S. infravalanginiensis** (Choffat) cannot be referred any longer to the genus **Spirocyclina** (with its type species **S. choffati** Munier-Chalmas from the Senonian of Martigues, southern France). On account of their interior structure, the forms **lusitanica** and **infravalanginiensis** from Portugal and the Tethys province differ generically from **S. choffati** Munier-Chalmas, a fact which had been anticipated (Maync, 1938, 1952). The forms **"S." lusitanica** and **"S." infravalanginiensis** show a characteristic reticulate sub-epidermal layer, have choffatelloid, i.e. regularly pierced septa, and regularly spaced interseptal partitions forming rectangular chamberlets are lacking. The Senonian **S. choffati**, on the other hand, possesses simple, not choffatelloid septa; the chambers are subdivided by secondary radial septula into rectangular chamberlets (near the surface of the test the chambers are intricately subdivided by a reticulate meshwork). Hence the forms **lusitanica** and **infravalanginiensis** will have to be removed from the genus **Spirocyclina** Munier-Chalmas, 1887. In view of the inevitable changes in the nomenclature, the choffatelloid genera of the Spirocyclininae Maync, 1950, are now grouped in the new subfamily Choffatellinae, n. subfam.

The samples which contain specimens of the new genus *Feurtillia* have been collected at the following localities:

Feurtille (P. 612 SSE Baulmes, about 8 km west-northwest of Yverdon, Lake Neuchâtel); uppermost Purbeckian (sample Burri No. 183; see Bartenstein & Burri, 1954, p. 428; Burri, 1957, p. 627-628).

Twann on Lake Biel (south of Schützenhaus); basal Berriasian (sample Burri No. 85; see Bartenstein & Burri, 1954, p. 441; Burri, 1957, p. 617).

Le Landeron (west of Lake Biel); basal Upper Valanginien (Marnes d'Arzier) (sample Burri No. 3a; see Bartenstein & Burri, 1954, p. 441; Burri, 1957, p. 619).

In the two first-named localities, *Feurtillia* occurs abundantly whereas it is exceedingly rare in the washed residue from Le Landeron.

SYSTEMATIC DESCRIPTION

Family LITUOLIDAE

Subfamily CHOFFATELLINAE, n. subfam.

Genus **Feurtillia** Maync, n. gen.

Plate 1, figures 1-5

Plate 2, figures 1-10

1954 *Pseudocyclammina:* BARTENSTEIN, Eclogae Geol. Helv., Vol. 47, No. 2, p. 428, Pl. XXVIII.

1957 *Pseudocyclammina:* BARTENSTEIN, Eclogae Geol. Helv., Vol. 49, No. 2, p. 628.

1957 *?Pseudocyclammina* or *?Ammobaculites:* BARTENSTEIN, Eclogae Geol. Helv., Vol. 49, No. 2, p. 617.[2]

Derivatio nominis.—Locality Feurtille, south-southeast of Baulmes (about 8 km west-northwest of Yverdon, Lake Biel, Ct. Bern).

Type species.—*Feurtillia frequens,* n. sp., Pl. 1, figs. 1-4.

Paratypes.—Pl. 1, fig. 5; Pl. 2, figs. 1-10.[3]

2 The specimens of **Feurtillia frequens** present in the foraminiferal slides No. 183 and No. 85 (collection Burri-Bartenstein) had been distinguished as "?**Choffatella** 3" and "?**Choffatella** 2," respectively.

3 Holotype and figured paratypes are deposited in the micropaleontological collection of the Museum of Natural History in Basel, Switzerland.

Locus typicus.—Feurtille, P. 612 south-southeast of Baulmes, about 8 km west-northwest of Yverdon, Lake Biel, Ct. Bern.

Diagnosis.—A genus of the choffatelline group of the Lituolidae, showing a test like a small, more or less compressed *Ammobaculites;* presence of a characteristic reticulate sub-epidermal meshwork; aperture a large slit in the plane of coiling.

Feurtillia frequens Maync, n. sp.

Description.—Test ammobaculitoid, generally more or less compressed (in extreme cases externally similar to *Ammomarginulina*); involute, close-coiled, bilaterally symmetrical; initial coil regular, planispiral, in small-sized specimens followed by a well-pronounced straight, uniserial portion which is occasionally slightly off the plane of coiling; in larger microspheric tests, a truly detached rectilinear adult stage is not always reached; outline even, sometimes slightly lobulate; 10-12 chambers in the last-formed volution, up to 6 chambers in the uniserial part; sutures indistinct, gently curved, in the rectilinear portion of the small tests nearly straight; recurved septa about as thick as the width of the chambers, more or less compact, sometimes containing a few vacuoles; wall very finely arenaceous with much calcareous cement or uniformly microgranular, smoothly finished; presence of a delicate thin sub-epidermal meshwork of alveoles; aperture a long vertical slit on the septal face in the axis of coiling.

Measurements.—Holotype (Pl. 1, figs. 1-4): Spiral diameter: 0.57 mm; greatest diameter: 0.65 mm; axial diameter (thickness): 0.20 mm.

The large-sized tests show an average spiral diameter (b) of 0.42-0.62 mm; the maximum diameter of these tests varies between 0.65 and 1.00 mm, the axial diameter (c) between 0.17 and 0.28 mm.

In the small tests, the spiral diameter (b) ranges between 0.26 mm and 0.37 mm, the total length (including the uniserial portion) varies between 0.40 and 0.68 mm, and the thickness of the test generally amounts to 0.12-0.14 mm.

The ratio ø (b:c) ranges between 1.90 and 3.17 (larger tests), in other words, the spiral diameter (b) of the *Feurtillia* test is on an average 2.6 times as large as the axial diameter (c) or thickness. In the small tests, this ratio ø shows the same variations.

A minimum thickness of 0.09 mm was observed in a specimen with a spiral diameter of 0.31 mm (ratio ø = 3.44).

Relationship and differences.—The new monotypical genus *Feurtillia* can be characterized as a lituolid foraminifer with the external features of *Ammobaculites* or, when the test is strongly compressed, of *Ammomarginulina.*

Contrary to these forms, however, the new genus displays a delicate alveolar sub-epidermal layer (Pl. 2, figs. 1, 4) on account of which it cannot be aligned with the simple lituolid group (subfamily Lituolinae s. str.) but has to be grouped with the Choffatellinae, n. subfam. (*olim* Spirocyclininae; see footnote 1 on p. 1) which possesses a reticulate sub-epidermal layer and/or a labyrinthic interior wall structure.

From the other representatives of the choffatelline group (*Reticulophragmium, Cyclammina, Hemicyclammina, Pseudocyclammina, Choffatella,* etc.), *Feurtillia* differs in lacking the labyrinthic interior structure, i.e. the spongy character of the wall. Only the presence of the characteristic reticulate near-surface meshwork suggests that *Feurtillia* belongs to the subfamily Choffatellinae.

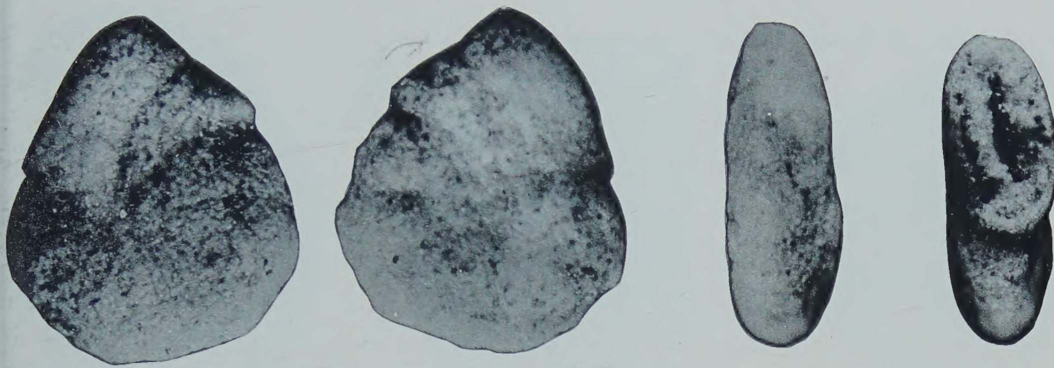
Another diagnostic feature of *Feurtillia* is the character of the aperture which is a long vertical slit in the axis of coiling while the externally similar choffatelline genera *Cyclammina, Hemicyclammina, Pseudocyclammina,* and *Choffatella* disclose multiple apertures (cribrate or a series of pores). Only *Reticulophragmium* shows a simple apertural opening, namely, a horizontal interio-marginal slit of *Haplophragmoides* type which has no relationship whatsoever with the linear aperture recognized in the genus *Feurtillia.*

Occurrence and stratigraphic position.—Up to the present, *Feurtillia frequens,* n. sp., has been found only in the Swiss Jura Mountains (Ct. Bern and Neuchâtel) between Lake Biel and Lake Neuchâtel (Twann, Le Landeron, Feurtille). Since *F. frequens* occurs here in great abundance, however, it is reasonable to assume that it will be recorded in the future from many other localities in the Jura Mountains.

At Feurtille near Baulmes, the new form characterizes the light-gray calcareous marls of the top beds of the Purbeckian (Bartenstein & Burri, 1954, p. 428; Burri, 1957, p. 628). Except for a great number of specimens of *F. frequens,* these marls contain a few other Foraminifera (*Ammobaculites, Eoguttulina, Len-*

EXPLANATION OF PLATE 1

Figs.		Page
1-5.	*Feurtillia frequens,* n. gen., n. sp. Upper Purbeckian, Feurtille, Swiss Jura Mountains .... 1-4, Holotype (external views). × 64. 1-2, Side views; 3, Peripheral view; 4, Apertural view. 5, External views of paratypes showing arrangement of chambers and morphological variations of tests. × 27.	1



1 2 3 4

5

Maync: *Feurtillia frequens*, n.gen., n.sp.

Maync: *Feurtillia frequens*, n.gen., n.sp.

ticulina, etc.) as well as some ostracods, viz. *Macrodentina retirugata* (Jones) and *Orthonotacythere favulata* Martin (Burri, 1957, p. 628). H. Oertli kindly examined the available residue and identified *Schuleridea* sp., *Candona* sp., *Cypridea* sp., *Protocythere*? sp., *Cytherella* sp., *Macrodentina* sp., and *Paracypris* sp. (oral communication). This association is held to be of Purbeckian age, mainly on account of the presence of the genus *Cypridea.* Below this *Feurtillia* level, a true Purbeckian population has been collected which includes *Planorbis* sp., *Cypridea fasciculata* (Forbes), *Cypridea granulosa* (Sowerby), *Orthonotacythere favulata* Martin, *Darwinula leguminella* (Forbes), *Macrodentina retirugata* (Jones), *Cyprideis polita* Martin, ?*Candona* sp., *Clavator. Aclistochara* sp., etc. (Bartenstein & Burri, 1954, Pl. XXVIII; Burri, 1957, p. 628). Both the listed species of *Cypridea* are diagnostic markers of the Serpulite and basal Wealdian beds of Germany. A marly limestone, 0.15 m. thick, showing a detrital microbreccia texture, is intercalated between this Purbeckian layer and the *Feurtillia*-bearing bed above (Burri, 1957, p. 628). The possibility that the Purbeckian elements in the *Feurtillia*-bed might be reworked ones cannot be entirely disregarded, accordingly.

The *Feurtillia*-bearing surface samples from near the northwestern border of Lake Biel are reported to be of basal Berriasian (Infravalanginian) and lowermost Upper Valanginian age, respectively (Bartenstein & Burri, 1954, Pl. XXVIII; Burri, 1957, p. 617, 619).

In the Berriasian sample (No. 85) from Twann, H. Bartenstein has identified *Valvulina* sp., *Choffatella* sp., *Ammobaculites* (?) sp., *Marssonella oxycona* (Reuss), *Marssonella* sp., and *Trocholina* sp. (Bartenstein & Burri, 1954, Pl. XXVIII). The ostracods which were kindly determined by H. Oertli, Chambourcy, include *Orthonotacythere favulata* Martin, *Schuleridea* sp., *Cyprideis*? sp., and *Candona* sp. In so far as the Foraminifera are concerned, this association reflects marine conditions, and also the basal Upper Valanginian faunule (sample No. 3a, etc.) is indicative of a marine environment; the Marnes d'Arzier from Le Landeron contain, *i.a., Choffatella decipiens* Schlumberger (writer's collection).

To sum up, *Feurtillia frequens,* n. gen., n. sp., as known at present ranges from the uppermost Purbeckian to the basal Upper Valanginian (Marnes d'Arzier).

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EXPLANATION OF PLATE 2

Figs.		Page
1-3.	*Feurtillia frequens,* n. gen., n. sp.; basal Berriasian, Twann (Lake Biel), Switzerland. × 64 .... 1, Shallow median section revealing reticulate sub-epidermal network; 2-3, Median section through equatorial plane displaying thick compact septa.	1
4-10.	*Feurtillia frequens,* n. gen., n. sp.; Upper Purbeckian, Feurtille, Swiss Jura Mountains. × 64 ...... 4, Near-surface section showing reticulate sub-epidermal layer; 5-6, Median sections disclosing thick compact septa; 7-8, Axial sections; 9-10, Median sections through small-sized specimens with a large rectilinear adult stage.	1

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
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177. CERTAIN SMALLER BRITISH PALEOCENE FORAMINIFERA PART III. POLYMORPHINIDAE

JOHN HAYNES

ABSTRACT

Thirty species and varieties of the foraminiferal family, Polymorphinidae, are described from the Thanet Beds of Kent in the United Kingdom; three of them are new.

INTRODUCTION

Scope of the paper.—This paper on *Polymorphina* and its allies is the third of a series representing the results of a taxonomic and stratigraphic revision of the foraminiferal fauna of the Thanet Beds of Kent in the United Kingdom. Thirty species and varieties are described.

Species previously recorded.—H. Burrows and R. Holland (1897) in their pioneer work on the Thanet Beds reported the occurrence of the following species:

Polymorphina lactea (Walker and Jacob)
Polymorphina gibba d'Orbigny var. *ampulla* Jones
Polymorphina amygdaloides (Reuss)
Polymorphina communis (d'Orbigny)
Polymorphina problema (d'Orbigny)
Polymorphina complanata (d'Orbigny)
Polymorphina complanata (d'Orbigny) var. *striata* Burrows and Holland.

Two of these species, *Polymorphina amygdaloides* and *P. complanata,* remained unsubstantiated by the present work. It is possible that the former should be included in *Pseudopolymorphina obtusa* (d'Orbigny), the latter in *Polymorphina* species A. *Polymorphina communis* and *P. problema* are grouped under one head, *Guttulina problema,* while *Polymorphina gibba* d'Orbigny var. *ampulla* Jones is described as *Globulina ampulla* (Jones).

Provenance.—Provenance of the species described is given in numbers referring to the stratigraphical columns illustrated in Certain Smaller British Paleocene Foraminifera, Part I (Haynes, 1956).

SYSTEMATIC PART

Family POLYMORPHINIDAE

Genus **Guttulina** d'Orbigny, 1826

Guttulina lactea (Walker and Jacob)

Plate 3, figures 1-1g

1784, *Serpula laevis ovalis* WALKER and BOYS, Testacea Minuta Rariora, p. 2, pl. 1, fig. 5.

1798, *Serpula lactea* WALKER and JACOB, in Adam's Essays, Ed. 2, p. 634, pl. 14, fig. 2.

1858, *Polymorphina lactea* WILLIAMSON (part), Foraminifera of the Coasts of Great Britain, p. 70, pl. 6, figs. 145-152.

1870, *Polymorphina lactea* BRADY, PARKER and JONES (part), Monograph of the Family Polymorphinidae, p. 213, pl. 39, figs. 1a, b.

1884, *Polymorphina lactea* BRADY, Sci. Rep. *Challenger* Exped., p. 559, pl. 71, fig. 11.

1897, *Polymorphina lactea* BURROWS and HOLLAND, Proc. Geol. Assoc., vol. 15, pts. 1 and 2, p. 45.

1926, *Polymorphina lactea* PLUMMER, Texas Univ. Bull., no. 2644, p. 121, pl. 4, figs. 7a-c.

1929, *Guttulina lactea* OZAWA, Contr. Cush. Lab. Foram. Res., vol. 5, p. 36, pl. 6, figs. 6-10.

1930, *Guttulina lactea* CUSHMAN and OZAWA, Proc. U. S. Nat. Mus., vol. 77, p. 43, pl. 10, figs. 1-4.

1948, *Guttulina lactea* BROTZEN, Sver. Geol. Undersök, Ars 42, ser. C, no. 493, p. 49, figs. 8, 10.

Distinguishing features.—A compressed, oval *Guttulina* with greatest width towards the initial end and elongate chambers that tend to reach back to the base.

Description.—(Plate 3, figs. 1a and 1b). Test compressed, oval, greatest width towards the initial end, apical end acuminate; chambers 5, elongate, sub-trigonal, embracing, reaching back to the initial end; sutures distinct, slightly impressed; megalospheric; aperture terminal, radiate; wall radiate; pores very minute.

Dimensions.—Length 0.36 mm.; maximum diameter 0.21 mm.

Horizon.—RB2, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42525.

Alternation of generations.—At least two generations can be discerned in the material from the Thanet Beds, one, possibly the microspheric generation shows up to seven chambers, the later chamber becoming removed from the base, while the other, possibly the megalospheric generation shows up to six chambers all tending to reach back to the base.

Variation.—In transverse section there is variation from an oval to a compressed shape.

Discussion.—Williamson included a number of forms from Recent seas (Irish coast) in *Polymorphina lactea,*

some of which have been distinguished as separate species by later authors. His *Polymorphina lactea* typica, examined in the British Museum of Natural History, is very near in form to the Thanet specimens and, as far as can be made out, to the figure of Walker and Boys, supposing this last to have been slightly compressed. The Thanet specimens differ from the Recent population in being smaller and developing fewer chambers, as do specimens from the Swedish and Texas Paleocene, and they may be a distinct variety.

Range.—Apparently throughout the Tertiary of America and N.W. Europe.

Guttulina lactea var. **elongata** Haynes, n. var.

Plate 3, figures 2-2b

Distinguishing features.—A variety of *Guttulina lactea* with elongate-ovate test and elongate embracing chambers.

Description.—(Plate 1, figs. 2, 2a). Test compressed, elongate-ovate, greatest width towards initial end, apical end acuminate; chambers 6, elongate, sub-trigonal, embracing, reaching back to the initial end; sutures distinct, slightly impressed; wall radiate; pores minute.

Dimensions.—Length 0.49 mm.; width 0.20 mm.

Horizon.—RB2, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42526. Additional specimens, P42527.

Alternation of generations.—All the specimens examined were apparently megalospheric.

Variation.—There is apparently a gradation from the typical *G. lactea* to such forms as that illustrated in figure 2b. The variety is less abundant than the species.

Guttulina cf. **G. kishinouyi** Cushman and Ozawa

Plate 3, figures 3, 3a

See 1930, *Guttulina kishinouyi* Cushman and Ozawa, Proc. U. S. Nat. Mus., vol. 77, p. 40, pl. 8, figs. 5-6.

Description.—Test elongate, semi-compressed, apical end acuminate, aperture produced; chambers 7, elongate, sub-trigonal, reaching back to the initial end; sutures distinct, slightly impressed; aperture terminal, radiate; wall radiate; pores minute.

Dimensions.—Length 0.55 mm.; maximum diameter 0.18 mm.

Horizon.—RB2, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42529 and P42530.

Discussion.—The specimen has the chamber shape of the Japanese Pliocene species but the apex is less tapering and the greatest width is nearer the middle.

Guttulina woodi Haynes, n. sp.

Plate 3, figures 4, 4a

Distinguishing features.—An elongate *Guttulina* with slightly produced apex, semi-parallel sides and a pointed initial end. It is compressed and ornamented with longitudinal striae.

Description.—Test elongate, compressed, greatest width towards the base, aperture slightly produced; chambers 6, elongate, sub-trigonal, tending to reach back to the base; sutures distinct, impressed; aperture terminal, radiate; wall radiate; pores minute; ornament of longitudinal striae.

Dimensions.—Length 0.42 mm.; maximum width 0.18 mm.

Horizon.—RB13, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42528.

Alternation of generations.—Not discerned. The type is probably megalospheric.

Discussion.—The species differs from *G. kishinouyi* Cushman and Ozawa in its smaller size, ornament and greater compression, and in its embracing, more elongate chambers from *G. spicaeformis* Roemer. This species is named in honour of Alan Wood.

Guttulina problema d'Orbigny

Plate 3, figures 5-5c

1826, *Guttulina problema* d'Orbigny, Ann. Sci. Nat., vol. 7, p. 26, 266, no. 14.

1826, *Polymorphina problema* d'Orbigny, Modèles no. 61.

1826, *Guttulina communis* d'Orbigny, ibid., p. 26, 266, no. 15.

1826, *Polymorphina communis* d'Orbigny, Modèles no. 62.

1846, *Guttulina problema* d'Orbigny, Foram. Foss. du Bass. Tert. de Vienne, Paris, p. 224, pl. 12, figs. 26, 28.

1846, *Guttulina communis* d'Orbigny, ibid., p. 224, pl. 13, figs. 6-8.

1858, *Polymorphina lactea* var. *communis* Williamson, Foram. of the Coasts of Great Britain, p. 70, pl. 6.

1884, *Polymorphina problema* Brady, Sci. Rep. *Challenger* Exped., vol. 9, p. 568, pl. 72, fig. 20, pl. 73, fig. 1.

1926, *Polymorphina communis* PLUMMER, Texas Univ. Bull., no. 2644, p. 123, pl. 6, figs. 12a-b.

1930, *Guttulina problema* CUSHMAN and OZAWA, Proc. U. S. Nat. Mus., vol. 77, p. 19, pl. 2, figs. 1-6.

1948, *Guttulina problema* BROTZEN, Sver. Geol. Undersök., Ser. C., no. 493, p. 49, figs. 10, 7.

1948, *Guttulina communis* BROTZEN, ibid., p. 49.

1953, *Guttulina problema* CUSHMAN, U. S. Geol. Survey Prof. Paper, 232, p. 32, pl. 9, figs. 15-18.

Distinguishing features.—An inflated, sub-globular *Guttulina* with rounded base and pointed apex. The chambers are up to about seven in number, becoming removed from the base. The greatest diameter is about the middle, rather lower in young forms.

Description.—(Plate 3, figs. 5, 5a). Test globose, ovate, rounded initial end, acute apex, greatest width towards the middle, trigonal in section; chambers about 7, successively removed from the base but not quite regularly; sutures impressed; aperture terminal, radiate; wall radiate; pores minute.

Dimensions.—Length 0.81 mm.; maximum width 0.60 mm.

Horizon.—P33, Pegwell Marls.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42531.

Alternation of generations.—Not discerned. The specimens recovered may all be megalospheric.

Discussion.—D'Orbigny listed *G. problema* and *G. communis* in 1826 and two models and some figures survive. The model of *Polymorphina communis* differs from the figures of *G. communis* in its greater number of chambers and in its acute apex. Cushman has supposed the model of *G. problema* ill made and that it has an abnormal third chamber. Examination of the model in the British Museum of Natural History shows that a different interpretation can be made; if a suture be interpolated, the test can be assumed to be composed of a normal quinqueloculine series arranged in an anticlockwise spiral.

D'Orbigny's descriptions of 1846 do not correspond to the original figures and models. *G. problema* is described in this case as differing from the acute apexed *G. communis* in possessing an obtuse apex. This is opposite to the previous distinction made between the two forms.

Brady, Parker, and Jones based their conception of *P. communis* on d'Orbigny's original figures and that of *P. problema* on model 61. Their drawing of the model is a distorted version and they assumed that the specific features of *P. problema* included an irregular crowding of chambers. On the basis of a Crag specimen, probably not specifically identical, they further supposed the chambers much inflated.

Cushman and Ozawa (1930) on the basis of topotypes from the Pliocene of Castel Arquato, followed Brady in including the two forms under one specific head, *G. problema,* and supposed the original figures of *G. communis* to represent young forms.

The question was re-opened by Brotzen (1948) who assigned short, broad forms to *G. communis* and smaller, more elongate forms to *G. problema,* thus following the original descriptions. He also stated that in many samples from the Cretaceous and Tertiary only the short, broad form occurs.

A short, broad form from the Thanet Beds is figured (Plate 3, fig. 5b). The length is not much greater than the width although there are seven chambers. The apertural end, however, is no more obtuse than that developed in the specimen described above. The majority of the Thanet specimens appear to be young and a different length, width ratio is shown at different stages, as well as a more obtuse apex in the more developed specimens.

On the basis of the Thanet specimens it is considered that the variants should be included under one name, especially as the possibilities of polymorphism are unknown.

Range.—Throughout the Tertiary of N. America and Europe.

Guttulina cf. **G. oregonensis** Bandy

Plate 3, figures 6, 6a

See 1944, *Guttulina oregonensis* BANDY, Journ. Pal., vol. 18, no. 4, p. 370, pl. 60, fig. 14.

Description.—Test oval, sub-globose, greatest width just above the middle, apex and initial end obtuse; chambers 4, tending to reach back to the initial end; sutures impressed; aperture damaged, terminal, apparently elliptical; wall radiate; pores minute.

Dimensions.—Length 0.65 mm.; maximum width 0.57 mm.

Horizon.—P16, Pegwell Marls.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42532.

Discussion.—Bandy distinguishes *G. oregonensis* from *G. irregularis* d'Orbigny by its obtuse apex, maximum width above the middle line and elliptical aperture. According to Cushman and Ozawa (1930) the figure of *G. irregularis* is much modified from the holotype which is triangular not globular. Their figures of topotypes are very near *G. oregonensis* and appear to show elliptical apertures. There is thus a possibility that *G. oregonensis* is a variety or growth form of *G. irregularis*.

Range.—Middle Eocene of Oregon.

Guttulina trigonula (Reuss)

Plate 3, figures 7-7b

1845, *Polymorphina trigonula* REUSS, Die Verstein der Bomischen Kreide, Geinitz Grunder Verstein, p. 40, pl. 13, fig. 84.

1870, *Polymorphina trigonula* BRADY, PARKER and JONES, Trans. Linn. Soc., p. 232, pl. 40, fig. 16a.

1930, *Guttulina trigonula* CUSHMAN and OZAWA, Proc. U. S. Nat. Mus., vol. 77, p. 28, pl. 4, figs. 2a-c.

1931, *Guttulina trigonula* CUSHMAN, Tennessee Geol. Bull. 41, p. 39, pl. 6, fig. 3.

1936, *Guttulina trigonula* BROTZEN, Sver. Geol. Undersök, vol. 30, no. 3, p. 113, pl. 7, figs. 13a-d.

1946, *Guttulina trigonula* VAN BELLEN, Med. Geol. Sticht, Ser. C-V, no. 4, p. 36, pl. 3, fig. 1.

1946, *Guttulina trigonula* CUSHMAN and RENZ, Contr. Cush. Lab. Foram. Res., Spec. Publ. 18, p. 34, pl. 5, fig. 20.

Distinguishing features.—A depressed, trigonal *Guttulina* with the adult chambers pinched up into a median ridge towards the aperture.

Description.—Test trigonal, depressed, chambers extending back to the flat initial end; chambers 7, inflated, the last two with a rounded ridge running down from the aperture; sutures distinct, slightly impressed; wall apparently silicified.

Dimensions.—Length 0.48 mm.; maximum width 0.62 mm.

Horizon.—P47, Reculver Silts. Presumed derived.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42533.

Discussion.—Brady, Parker, and Jones reproduced the minute figure of Reuss. This they idealized, leaving out the prominent and characteristic ridges. These are shown in the figures of topotypes given by Cushman and Ozawa but not mentioned in their description.

The specimen referred by Egger to this species in 1907 lacks these ridges and is less depressed. It is possibly nearer to *G. austriaca* d'Orbigny. These ridges are similarly lacking in the Netherlands Maestrichtian specimens of Visser (1951). As this author mentions the difficulty of separating them from *G. problema* d'Orbigny, except by their depression, they may represent a variation towards d'Orbigny's species. Van Bellen's citation is similarly doubtful.

Range.—Upper Cretaceous of Germany, Sweden, Tennessee, (Maestrichtian) Netherlands; Paleocene, Trinidad.

Guttulina cf. **G. laevigata** d'Orbigny

Plate 3, figures 9, 9a

See 1826, *Polymorphina (Guttulina) laevigata* D'ORBIGNY, Ann. Sci. Nat., vol. 7, p. 266, no. 9.

1908, *Guttulina laevigata* FORNASINI, R. Acad. Sci. Inst. Bologna, Ser. 6, vol. 5, p. 43, pl. 1, fig. 10.

Description.—Test sub-globular, possibly aberrant, almost round in section with broadly rounded base and acuminate apex; chambers 4, the third inflated and forming the greater part of the test, sutures distinct, slightly impressed; wall radial; pores minute.

Dimensions.—Length 0.53 mm.; greatest width 0.47 mm.

Horizon.—P22, Pegwell Marls.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42534.

Discussion.—This specimen, possibly abnormal, appears to be nearest *G. laevigata.*

Range.—Paleocene, Sweden; Lower Tertiary (Falunien), Bordeaux.

Genus **Pyrulina** d'Orbigny, 1839

Pyrulina fusiformis (Roemer)

Plate 3, figures 8-8i

1838, *Polymorphina fusiformis* ROEMER, Neues Jahrb. Min. Geog. Geol., p. 386, pl. 3, figs. 37a-b.

1851, *Polymorphina lanceolata* REUSS, Zeit. Deutsch. Geol., vol. 3, p. 83, pl. 6, fig. 50.

1855, *Polymorphina cylindroides* REUSS, Sitz. Akad. Wiss. Wien, vol. 18, p. 249, pl. 8, fig. 78.

1859, *Guttulina porrecta* REUSS, Sitz. Akad. Wiss. Wien, vol. 1, p. 86, pl. 12, fig. 4.

1860, *Polymorphina subteres* REUSS, Sitz. Akad. Wiss. Wien, vol. 40, p. 361, pl. 12, fig. 14.

1870, *Polymorphina fusiformis* BRADY, PARKER and JONES, Trans. Linn. Soc., p. 219, pl. 39, fig. 5.

1930, *Pyrulina fusiformis* CUSHMAN and OZAWA, Proc. U. S. Nat. Mus., vol. 77, p. 55, pl. 13, figs. 3-8.

1946, *Pyrulina fusiformis* VAN BELLEN, Med. Geol. Sticht. ser. C-V, no. 4, p. 40, pl. 3, fig. 2.

1948, *Pyrulina fusiformis* BROTZEN, Sver. Geol. Undersök., ser. C, no. 493, fig. 10, 4.

Distinguishing features.—An elongate *Pyrulina,* oval to round in section with the angle of its sutures in the adult part at 45° or less to the horizontal and the last chamber making up a third or more of the total length of the test.

Description.—(Plate 3, fig. 8b). Test elongate, with rounded base and tapering apex, oval in section; cham-

bers 4, biserial throughout, slowly increasing in size; sutures distinct but not impressed, arranged at about 45° to the horizontal; aperture terminal with radial grooves; wall radiate; pores minute; megalospheric.

Dimensions.—Length 0.58 mm.; diameter 0.16 mm.

Horizon.—RB1, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42535.

Alternation of generations.—There appear to be at least two groups of proloculus size, megalospheric specimens developing up to five chambers, microspheric specimens developing up to seven chambers and showing triserial arrangement in the initial part (Plate 3, fig. 8a).

Variation.—There is apparently variation in chamber shape and the shape of the initial end independently of polymorphism (Plate 3, figs. 8b, 8f).

Discussion.—The type figure is very small and subject to varied interpretation. Brady, Parker, and Jones grouped a great many forms described under different names in this species and figured *P. cylindrica* Bornemann and *G. porrecta* Reuss as typical forms. The apparent polymorphism of the Thanet population would appear to justify their views. Cushman and Ozawa found a similar variation in topotypes from the Upper Oligocene of Cassel. Microspheric forms were not mentioned although they appear to have illustrated one in their figure 6b.

Range.—Upper Cretaceous, Germany; Oligocene, Germany.

Genus **Globulina** d'Orbigny, 1839

Globulina gibba d'Orbigny

Plate 3, figures 10, 10a

1826, *Globulina gibba* d'Orbigny, Ann. Sci. Nat., vol. 7, p. 266, no. 10, Modèles no. 63.

1846, *Globulina gibba* d'Orbigny, Foram. Foss. du Bass. Tert. de Vienne, p. 227, pl. 13, figs. 13, 14.

1926, *Polymorphina gibba* Plummer, Texas Univ. Bull., no. 2644, p. 122, pl. VI, figs. 8a, b.

1930, *Globulina gibba* Cushman and Ozawa, Proc. U. S. Nat. Mus., vol. 77, p. 60, pl. 16, figs. 1-4.

1951, *Globulina gibba* Cushman, U. S. Geol. Surv. Prof. Paper 232, p. 33, pl. 9, figs. 26-28.

Distinguishing features.—A sub-spherical *Globulina* with up to seven chambers, only three of which are visible in side view.

Description.—Test sub-spherical, circular in transverse section; chambers 7, inflated, embracing; sutures distinct, flush; aperture terminal, with radial grooves and short internal tube; wall radiate; pores minute.

Dimensions.—Length 0.44 mm.; diameter 0.39 mm.

Horizon.—RB17, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42536.

Variation.—Specimens up to 0.5 mm. in length occur. Some times the shape is more elongate and the aperture slightly produced.

Discussion.—The Thanet specimens closely conform to the shape and chamber arrangement of d'Orbigny's model, no. 63. The topotypes described by Cushman and Ozawa show that the species is characterized both by almost spherical forms as well as by more elongate forms such as d'Orbigny's model. The Thanet specimens fall at the lower end of the size range given by Cushman and Ozawa, length 0.45 mm. to 1.1 mm.

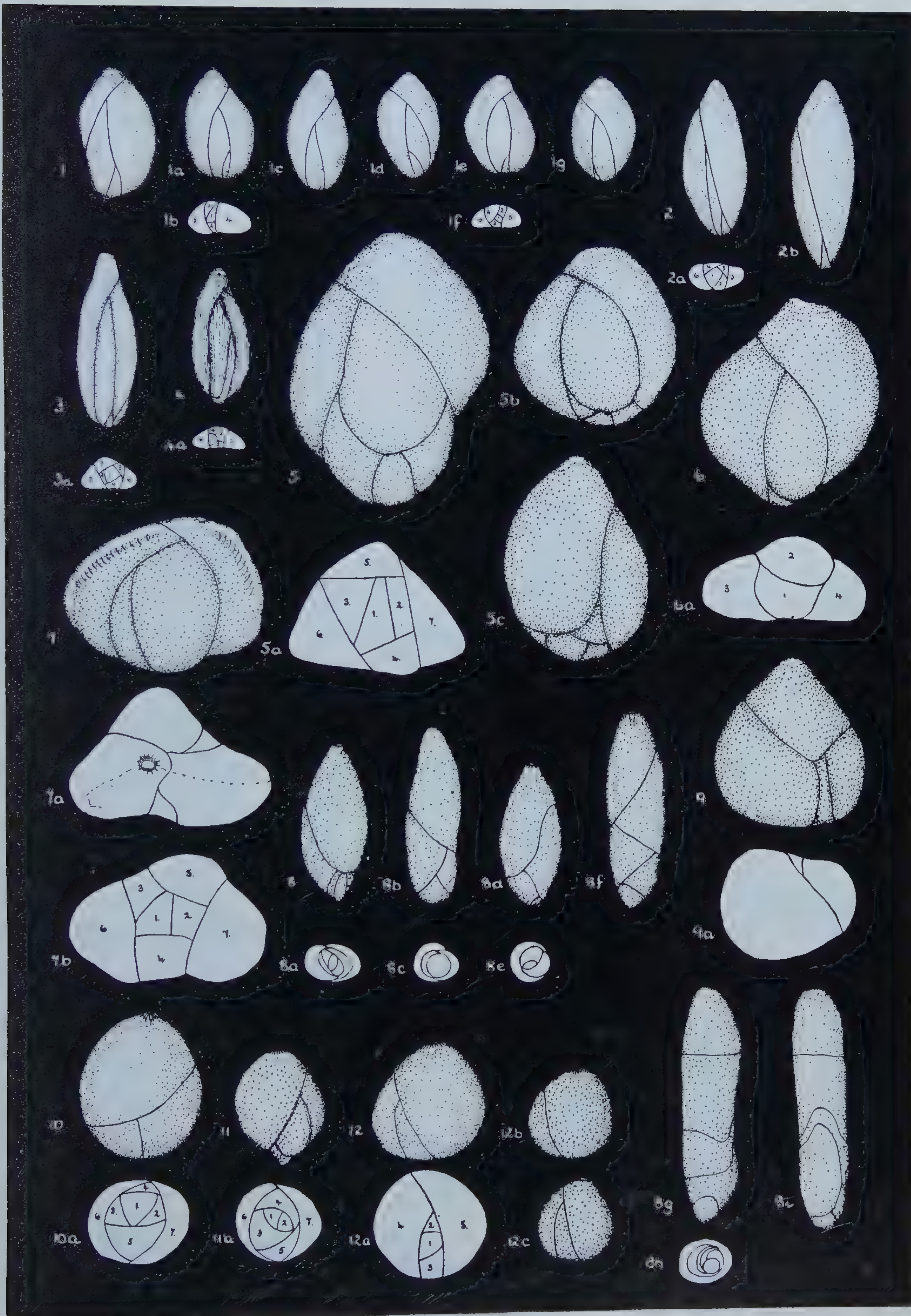
The range of variation in the specimens recovered supports the views both of Brady and of Cushman and Ozawa who interpreted the species widely, lumping many of the species and varieties of previous workers under its head; this applies especially to the species of Terquem and Egger. Some of the Thanet specimens show a marked similarity to the various

EXPLANATION OF PLATE 3

All figures × 50

Figs.		Page
1.	*Guttulina lactea* (Walker and Jacob); 1a-g, megalospheric forms	4
2.	*Guttulina lactea* var. *elongata* Haynes, n. var., holotype; 2a, basal view; 2b, well grown specimen	5
3.	*Guttulina* cf. *G. kishinouyi* Cushman and Ozawa; 3a, basal view	5
4.	*Guttulina woodi* Haynes, n. sp., holotype; 4a, basal view	5
5.	*Guttulina problema* d'Orbigny; 5a, basal view; 5b, broad young form; 5c, elongate young form	5
6.	*Guttulina* cf. *G. oregonensis* Bandy; 6a, basal view	6
7.	*Guttulina trigonula* Reuss; 7a, apertural view; 7b, basal view	7
8.	*Pyrulina fusiformis* (Roemer); 8b and 8f, megalospheric forms; 8d, microspheric form; 8g, a possible distorted specimen, 8i, rear view of distorted specimen	7
9.	*Guttulina* cf. *G. laevigata* d'Orbigny; 9a, basal view	7
10.	*Guttulina gibba* d'Orbigny; 10a, basal view	8
11.	*Guttulina gibba* var. A; 11a, basal view	9
12.	*Guttulina gibba* var. *hollandi* Haynes, n. var., holotype; 12a, basal view; 12b and 12c, smaller specimens	9

N. B. Basal views are plan views only



Haynes: British Paleocene Foraminifera

Haynes: British Paleocene Foraminifera

forms distinguished by Terquem as separate species from the lower Eocene of the Paris Basin, particularly *G. transversa* and *G. ponderosa* in which the chambers tend not to reach so far back towards the initial end.

Polymorphina inflata Terquem and Terquem is included in the synonymy of Cushman and Ozawa but would appear nearer *Glandulina* than *Globulina*. Brady's *Globulina gibba*, described in the Challenger Report, is compressed and should probably be placed under *G. globosa* (Münster).

Range.—Throughout the Tertiary of N. America and Europe.

Globulina gibba var. A

Plate 3, figures 11, 11a

1894, *Polymorphina cognata* FRANZENAU, (homonym of *P. cognata* STACHE, 1865), Soc. Hist. Nat. Croatica, god. 6, broj. 6, p. 35, pl. 6, figs. 59a-c.

Distinguishing features.—A variety of *G. gibba* with a short spine.

Description.—Test sub-spherical with a spine; chambers 7, inflated, embracing; sutures distinct, slightly impressed; aperture terminal with radial grooves; wall radiate; pores minute.

Dimensions.—Length 0.36 mm.; diameter 0.275 mm.

Horizon.—RB2, Reculver Silts.

Depository.—Only one specimen was recovered and this unfortunately was lost after it was figured.

Range.—Tertiary, Yugoslavia.

Globulina gibba var. **hollandi** Haynes, n. var.

Plate 3, figures 12-12c

Distinguishing features.—A depressed variety of *G. gibba* with greatest width towards the base and more embracing chambers.

Description.—(Plate 3, figs. 12, 12a). Test subspherical, round in section, greatest width towards the base; chambers 5, inflated, embracing and reaching back to the initial end; sutures distinct, flush; aperture terminal with radial grooves; wall radiate; pores minute.

Dimensions.—Length 0.37 mm.; diameter 0.36 mm.

Horizon.—RB6, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42537. Additional specimens P42538.

Discussion.—This variety has the shape of *G. inequalis* Reuss but is round in section like *G. gibba*, not compressed. It thus appears to stand midway between these two species.

Derivation of name.—In honour of R. Holland, a pioneer worker on the Thanet Beds.

Globulina ampulla (Jones)

Plate 4, figures 1-1f

1852, *Polymorphina ampulla* JONES, Quart. Journ. Geol. Soc., vol. 8, p. 267, pl. 16, fig. 14.

1855, *Guttulina rotundata* BORNEMANN, Zeit. Deutsch. Geol. Ges., vol. 7, p. 366, pl. 18, fig 3.

1855, *Guttulina fracta* BORNEMANN, ibid., p. 344, pl. 17, fig. 4.

1855, *Guttulina incurva* BORNEMANN, ibid., p. 345, pl. 17, fig. 6.

1855, *Guttulina globosa* BORNEMANN, ibid., p. 346, pl. 18, fig. 1.

1855, *Guttulina obtusa* BORNEMANN, ibid., p. 346, pl. 18, fig. 2.

1855, *Polymorphina turgida* REUSS, Sitz. Akad. Wiss. Wien, vol. 18, p. 246, pl. 6, fig. 66.

1870, *Polymorphina rotundata* BRADY, PARKER and JONES, Mon. of the Family Polymorphinidae, p. 234, pl. 40.

EXPLANATION OF PLATE 4

Figure 1, × 50; all others × 30

FIGS.		PAGE
1.	*Globulina ampulla* (Jones); 1a, basal view; 1b-1f, varieties	9
2.	*Sigmomorphina ? bombasta* Haynes, n. sp., holotype; 2a, basal view; 2b and 2c, additional specimens	10
3.	*Sigmomorphina ? sporadica* Haynes, n. sp., holotype; 3a, basal view; 3b and 3c, additional specimens	11
4.	*Sigmomorphina* cf. *S. semitecta* var. *terquemiana* Cushman and Ozawa	10
5.	*Sigmomorphina* sp. A	11
6.	*Sigmomorphina* sp. B; 6a, basal view	11
7.	*Pseudopolymorphina paleocenica* Brotzen; 7a, basal view; 7b, young specimen	11
8.	*Polymorphina* sp. B	13
9.	*Polymorphina anceps* Philippi; 9a, basal view; 9b and 9c, young microspheric specimen	12
10.	*Polymorphina* sp. A; 10a, basal view; 10b and 10c, additional specimens	13
11.	*Pseudopolymorphina obtusa* (d'Orbigny); 11a-d, additional specimens	12
12.	*Polymorphina striata* Burrows and Holland. Variety near *Pseudopolymorphina geijeri* Brotzen	12
13.	*Polymorphina striata* Burrows and Holland; 13a, basal view; 13b, smooth	12

N. B. Basal views are plan views only

1897, *Polymorphina gibba* var. *ampulla* BURROWS and HOLLAND, Proc. Geol. Assoc., vol. 15, pts. 1 and 2, p. 45, pl. 2, fig. 14.

1930, *Globulina rotundata* CUSHMAN and OZAWA, Proc. U. S. Nat. Mus., vol. 77, p. 86, pl. 21, figs. 3, 4.

1932, *Globulina rotundata* HOWE and WALLACE, Louisiana Dept. Cons. Geol. Bull., no. 2, p. 47, pl. 15, fig. 4.

1935, *Globulina rotundata* CUSHMAN, U. S. Geol. Surv. Prof. Paper 181, p. 27, pl. 9, fig. 24.

1944, *Globulina rotundata* CUSHMAN, Contr. Cush. Lab. Foram. Res., vol. 20, pt. 2, p. 40, pl. 6, figs. 20-22.

1946, *Globulina rotundata* CUSHMAN, Contr. Cush. Lab. Foram. Research, Spec. Pub. 16, p. 19, pl. 4, figs. 14, 15.

1946, *Globulina rotundata* CUSHMAN and TODD, Contr. Cush. Lab. Foram. Res., vol. 22, pt. 2, p. 56, pl. 10, fig. 4.

1948, *Globulina rotundata* BROTZEN, Sver. Geol. Undersök., ser. C, no. 493, p. 48 (listed only).

1951, *Globulina rotundata* CUSHMAN, U. S. Geol. Surv. Prof. Paper 181, p. 33, pl. 9, figs. 29-33.

Distinguishing features.—A sub-globular to elongate-ovate *Globulina* with acuminate apex. There are up to seven chambers in the adult (presumably megalospheric) forms. In the sub-globular forms the terminal chambers reach approximately one third of the way to the base. From these specimens there is continuous variation to elongate-ovate specimens in which the terminal chambers reach over two thirds of the way to the base.

Description.—(Plate 4, figs. 1, 1a). Test elongate-ovate, round in section with acute apex and rounded initial part; chambers 7, semi-inflated, successively removed from the base, the terminal chamber reaching about halfway to the base; sutures distinct, flush; aperture terminal with radial grooves; wall radiate; pores minute.

Dimensions.—Length 0.57 mm.; diameter 0.36 mm.

Horizon.—RB8, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42539.

Variation.—No marked proloculus size groups were discerned and there is apparently considerable variation apart from alternation of generations. There is a gradation from sub-globular forms (fig. 1c) with short, terminal chambers to specimens with chambers reaching over two thirds of the way to the base (figs. 1b, 1f).

Discussion.—This species was interpreted by Burrows and Holland as a variety of *Globulina gibba,* the specimen figured by these authors being immature. The specimen described as *G. ampulla* by Cushman and Ozawa from the Bracklesham Beds may be a variety of *G. gibba* and the same may be true of *Globulina ampulla* in van Bellen's sense.

The large number of specimens collected during the present investigation shows that the Thanet population is identical with the population from the Septarian Clays (Oligocene), grouped under *G. rotundata* by Brady, Parker and Jones. The Thanet specimen described above is very near figure 3 of Cushman and Ozawa and differs from Bornemann's type figure only in its slightly more pointed apex. The Thanet specimens illustrated (Plate 4, figs. 1c, 1d) show the extreme of inflation with short chambers similar to specimens illustrated by Cushman and Ozawa. Bornemann's *G. ovalis* comes nearest the elongate Thanet specimens.

Range.—Paleocene, Sweden; Eocene, Louisiana; Oligocene, Germany.

Genus **Sigmomorphina** Cushman and Ozawa, 1928

Sigmomorphina cf. **S. semitecta** var. **terquemiana** Cushman and Ozawa

Plate 4, figures 4, 4a

See 1930, *Sigmomorphina semitecta* var. *terquemiana* CUSHMAN and OZAWA, Proc. U. S. Nat. Mus., vol. 77, p. 129, pl. 33, figs. 4, 5.

Description.—Test compressed, elongate-ovate, with pointed apical and initial ends; chambers 5, trigonal, embracing and tending to reach back to the base; sutures distinct, depressed; aperture terminal with radial grooves; wall radiate; pores minute.

Dimensions.—Length 0.51 mm.; maximum width 0.27 mm.

Horizon.—P16, Pegwell Marls.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42540.

Discussion.—The specimen recovered is rather more elongate and more pointed initially than Cushman's specimens, coming nearest to the specimens figured by Cushman (1951, pl. 10, figs. 2, 3) in the monograph on U. S. Paleocene Foraminifera. *S. wilcoxensis* Cushman and Ponton is more elongate and acuminate with chambers becoming removed from the base.

Sigmomorphina? bombasta Haynes, n. sp.

Plate 4, figures 2-2c

Distinguishing features.—An elongate, compressed *Sigmomorphina* with up to eight chambers, rhomboidal in outline and broadly rounded both at the initial and apical ends.

Description.—(Plate 4, figs. 2, 2a). Test elongate, compressed, rhomboidal in side view; chambers 8, elongate, semi-inflated, in a clockwise, aberrant, sigmoid series; terminal chamber short; sutures distinct, flush; aperture terminal, broken; wall radiate; pores minute.

Dimensions.—Length 1.37 mm.; maximum diameter 0.70 mm.

Horizon.—P22, Pegwell Marls.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42541. Additional specimens P42542.

Discussion.—A few specimens were recovered of this variable but distinctive form. It differs from *S. soluta* Brotzen (from the Swedish Paleocene) in its bluntly rhomboidal form and in its flush sutures.

Sigmomorphina? sporadica Haynes, n. sp.

Plate 4, figures 3-3c

Distinguishing features.—An elongate, possibly aberrant *Sigmomorphina* with rounded base and pointed apex. In the younger portion of the test the irregularly sigmoid chambers tend to be short whereas in the older portion of the test the chambers tend to be elongate and extend back towards the base.

Description.—(Plate 4, figs. 3, 3a). Test elongate; chambers 8, irregularly arranged, the first three after the proloculus developed on the same side, the third overlapping the others and extending back towards the base, the fifth and sixth developed on the other side and almost uniserial, the last two chambers regularly biserial; sutures distinct, flush; aperture terminal with radial grooves; wall radiate; pores minute; ornament of faint striation on the fifth and sixth chambers.

Dimensions.—Length 1.27 mm.; maximum diameter 0.50 mm.

Horizon.—P35, Pegwell Marls.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42543. Additional specimens P42544.

Variation.—The irregular growth and chamber shape in this species produces shape varieties that are almost equal in number to the number of individuals collected. The specimens figured are, however, very similar in the arrangement of the younger chambers. The specimen illustrated in fig. 3b shows a very irregular spiral of growth but the terminal chambers are developed as in the holotype. In fig. 3c an individual is shown in which only the last two chambers show great elongation. These terminal chambers are developed on the same side thus giving rise to the narrow shape of the whole test.

Discussion.—It is not easy to place this species in the present classification of genera within the Polymorphinidae. The short, irregularly arranged chambers in the initial part resemble those found in the adult parts of such species of *Pseudopolymorphina* as *P. jonesi* Cushman and Ozawa, whereas the terminal chambers resemble those developed in the adult parts of *Sigmomorphina* or *Polymorphina*.

Sigmomorphina species A

Plate 4, figure 5

Description.—Test elongate, initial end pointed, apex produced; chambers 7, arranged in an unequal sigmoid, biserial series, 5 on one side, 2 on the other; sutures distinct, impressed; aperture terminal, produced, with radial grooves; wall radiate; pores minute.

Dimensions.—Length 0.67 mm.; maximum width 0.20 mm.

Horizon.—RB3, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42545.

Discussion.—The specimen is unlike any other found in the washings from the Thanet Sands and apparently unlike any so far described.

Sigmomorphina species B

Plate 4, figures 6, 6a

Description.—Test elongate, rhomboidal; chambers 5, arranged in an irregular guttuline spiral, short, embracing; sutures distinct, slightly impressed; aperture terminal with radial grooves; wall radiate; pores minute.

Dimensions.—Length 0.59 mm.; width 0.30 mm.

Horizon.—P35, Pegwell Marls.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42546.

Discussion.—The specimen is near *Sigmomorphina soldadoensis* Cushman and Renz but has shorter chambers and is less compressed.

Genus **Pseudopolymorphina**

Cushman and Ozawa, 1928

Pseudopolymorphina paleocenica Brotzen

Plate 4, figures 7-7b

1948, *Pseudopolymorphina paleocenica* Brotzen, Sver. Geol. Undersök., ser. C, no. 493, p. 50, text fig. 11.

Distinguishing features.—An elongate, parallel sided *Pseudopolymorphina* with up to thirteen short chambers and ornament of longitudinal striae.

Description.—(Plate 4, fig. 7). Test broken, elongate, oval in section with parallel sides; chambers 6, arranged at 140° to each other in the initial part, bi-

serially in the remaining part; sutures distinct, slightly impressed, crossing the test at about 45° to the horizontal; wall radiate; pores minute; ornament of longitudinal striae.

Dimensions.—Length 1.05 mm.; maximum diameter 0.40 mm.

Horizon.—P48, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42548.

Range.—Paleocene, Sweden, England.

Pseudopolymorphina obtusa (d'Orbigny)

Plate 4, figures 11-11d

1825, *Polymorphina obtusa* D'ORBIGNY (*nom. nud.*), Planches Inédites, p. 99, and p. 265.

1850, *Polymorphina obtusa* D'ORBIGNY, Prodrome de Pal. Strat., vol. 2, p. 408.

1900, *Polymorphina obtusa* FORNASINI, Bull. Soc. Geol. Italy, vol. 19, p. 146, fig. 4.

Distinguishing features.—An elongate ovate, short chambered *Pseudopolymorphina* with pointed apical and initial ends. There are up to ten chambers in microspheric forms, up to six chambers in biserial, megalospheric forms.

Description.—(Plate 4, fig. 11). Test elongate ovate with pointed ends, oval in transverse section; chambers 7, arranged in a slightly sigmoid, biserial series, short; sutures distinct, flush; aperture terminal with radial grooves; wall radiate; pores minute.

Dimensions.—Length 0.66 mm.; maximum diameter 0.38 mm.

Horizon.—P51, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42549.

Alternation of generations.—There appear to be at least two groups of proloculus size, the microspheric generation possessing an initial quinqueloculine initial part, the megalospheric generation biserial throughout.

Range.—Lower Tertiary, Paris Basin; Paleocene, England.

Genus **Polymorphina** d'Orbigny, 1826

Polymorphina anceps Philippi

Plate 4, figures 9-9c

1843, *Polymorphina anceps* PHILIPPI, Beitrage zur Kent. der Tert. Verstein. der Nordwest. Deutsch., Cassel, pp. 47, 70, pl. 1, figs. 34, 34a.

Distinguishing features.—An elongate ovate, compressed *Polymorphina* with a raised median ridge and faint ornament of striae. There are up to seven chambers in megalospheric forms and possibly more in microspheric specimens.

Description.—(Plate 4, figs. 9, 9a). Test elongate ovate, compressed, raised into a ridge along the median line, producing a leaf-like form; chambers 7, elongate, biserial throughout, slowly increasing in size; the terminal chambers extending over two thirds of the way to the base; sutures flush at 25° to the vertical axis; aperture terminal, produced, with radial grooves, wall radiate; pores minute; ornament of longitudinal striae restricted to the lower middle part of the test.

Dimensions.—Length 2.03 mm.; maximum diameter 1.01 mm.

Horizon.—P24, Pegwell Marls.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42547.

Alternation of generations.—There appear to be at least two groups of proloculus size, the initial part in the microspheric generation showing quinqueloculine arrangement (figs. 9b, 9c).

Discussion.—The description of the holotype by Philippi included the observation that the specimen was vaulted in the middle line but his figures show an oval cross section. The side view, however, illustrates a specimen identical in shape and ornament with the Thanet specimen described.

Brady, Parker and Jones (1870), in their monograph on the Polymorphinidae, lumped this species under *Polymorphina complanata* d'Orbigny, a smooth form lacking the median ridge and striation of *P. anceps*. These authors drew figures after Reuss and took his *P. complanata*, with greatest width near the base, as typical. It is very doubtful if Reuss' species is the same as d'Orbigny's species.

Range.—Lower Tertiary, Germany; Paleocene, England.

Polymorphina striata (Burrows and Holland)

Plate 4, figures 12, 12a, 13-13b

1897, *Polymorphina complanata* var. *striata* BURROWS and HOLLAND, Proc. Geol. Assoc., vol. 15, p. 46, pl. 12, fig. 15.

1930, *Polymorphina longistriata* CUSHMAN and OZAWA, Proc. U. S. Nat. Mus., vol. 77, p. 46, pl. 2, fig. 15.

Distinguishing features.—An elongate, compressed *Polymorphina* with elongate ovate to rhomboidal outline and up to eight chambers slowly increasing in size. There is ornament of longitudinal striae.

Description.—(Plate 4, figs. 13, 13a). Test elongate, compressed, outline rhomboidal; chambers 6, biserial throughout, slowly increasing in size; sutures distinct, flush, slightly sigmoid; aperture terminal with radial

grooves; wall radiate; pores minute; ornament of longitudinal striae.

Dimensions.—Length 0.83 mm.; maximum width 0.33 mm.

Horizon.—RB3, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42551. Additional specimen P42550.

Variation.—Of the two other specimens recovered one shows the same rhomboidal outline as the specimen described above (Plate 4, fig. 13b) but is without ornament. The other specimen (Plate 4, figs. 12, 12a) is oval in outline and with sutures that are gently curved and convex to the apertural end rather than with a tendency to be concave to the apertural end and sigmoid. In these characters the specimen shows an approach towards *Pseudopolymorphina geijeri* Brotzen from the Swedish Paleocene.

Discussion.—Burrows and Holland made their specimen a variety of *Polymorphina complanata* d'Orbigny. In 1930, Cushman and Ozawa raised the variety to a species with the name *P. longistriata*. As there are no grounds for the change of name it should revert to *P. striata*.

Range.—This species has not yet been found outside the Thanet Beds.

Polymorphina eolithiformis Haynes, n. nom.

Plate 5, figures 4-4c

1825, *Polymorphina acuta* D'ORBIGNY (*non* D'ORBIGNY 1846), Planches Inédites, p. 99, p. 265.

1900, *Polymorphina acuta* FORNASINI (*non* CONTI, SEGUENZA and COPPI), Bull. Soc. Geol. Italy, Vol. 19, p. 135 (text fig.).

Distinguishing features.—A *Polymorphina* with slightly sigmoid, elongate chambers which become smaller at the apex.

Description.—(Plate 5, figs. 4, 4a). Test elongate, slightly compressed, rounded at the base with acuminate apex; chambers 5, decreasing in size, in an unequal, slightly sigmoid, biserial series, four on one side, one on the other; sutures distinct, slightly impressed; aperture terminal with radial grooves; wall radiate; pores minute.

Dimensions.—Length 0.71 mm.; maximum width 0.26 mm.

Horizon.—RB1, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42552.

Discussion.—As is the case with certain other species the specimen designated by d'Orbigny as the type of *Polymorphina acuta* in the Planches Inédites is a different species from that described under the same name in later papers. The specimen described as *Polymorphina acuta* in the Vienna Basin Monograph (d'Orbigny, 1846) (which has priority over Fornasini 1900) has numerous biserial chambers slowly increasing in size and is not much compressed. The specimen originally described under this name, and figured by Fornasini, is very similar to the Thanet specimens in form although the shortening of the terminal chamber is not so marked and the chambers as a whole more inflated.

Certain specimens placed under *Polymorphina acuta* by Heron-Allen and Earland were examined in the British Museum. The specimens from the Coralline Crag resemble the specimens from the Thanet Beds but are much larger. The specimens from Sydney Harbour resemble *Polymorphina acuta* 1846.

Range.—Lower Tertiary (Falunien), France.

Polymorphina species A

Plate 4, figures 10-10c

Description.—(Plate 4, figs. 10b, 10c). Test subrhomboidal, compressed, initial end broadly rounded, apex pointed; chambers 7, arranged in a regular biserial series; sutures distinct, sigmoid; aperture terminal with radial grooves; wall radiate; pores minute; ornament of faint striae partially developed.

Dimensions.—Length 1.05 mm.; maximum width 0.54 mm.

Horizon.—P35, Pegwell Marls.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42553.

Discussion.—The additional specimen figured (Plate 4, figs. 10, 10a) may belong to the same species as that described above, differing in its stunted later chambers and lack of ornament. This species is near *P. cushmani* Plummer from the Alabama Paleocene but lacks the marked median costulations characteristic of it.

Polymorphina species B

Plate 4, figure 8

Description.—Test elongate with rounded initial end and acuminate apex; chambers 6, arranged in a biserial series, the last two extending back to the base; sutures distinct, flush; aperture terminal with radial grooves; wall radiate; pores minute.

Dimensions.—Length 0.86 mm.; maximum diameter 0.5 mm.

Horizon.—RB2, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42553.

Genus **Glandulina** d'Orbigny, 1826

Glandulina? laevigata d'Orbigny

Plate 5, figures 1-1e

1826, *Nodosaria (Glandulina) laevigata* D'ORBIGNY, Ann. Sci. Nat., vol. 7, no. 1, pl. 10, figs. 1-3.

1846, *Glandulina laevigata* D'ORBIGNY, Foram. Foss. du Bass. Tert. de Vienne, pl. 1, figs. 1-3.

Distinguishing features.—A sub-globular *Glandulina* in which the initial chambers are triserial in the microspheric generation and uniserial in the megalospheric generation. The terminal chamber makes up the greater part of the test.

Description.—(Plate 5, figs. 1, 1a). Test globular, initial end pointed and spined, apex acuminate, terminal chamber making up more than half the total length; chambers 6, triserial in the initial part, the last 2 uniserial; sutures distinct, impressed; aperture terminal with radial grooves and short internal tube; wall radiate; pores minute.

Dimensions.—Length 0.62 mm.; maximum width 0.34 mm.

Horizon.—P35, Pegwell Marls.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42554.

Alternation of generations.—At least two groups of proloculus size can be distinguished, one microspheric, with up to six chambers (of which those in the initial part are triserial) and at least one, possibly two, groups of uniserial megalospheric specimens with from three to four chambers (Plate 5, figs. 1c-1e).

Discussion.—The Thanet specimens compare closely with d'Orbigny's figures and descriptions. There are differences in that neither the 1826 or the 1846 figures show initial biserial or triserial chambering. However, study of topotype material from the Miocene of Baden by Cushman and Ozawa (1930, p. 143) reveals that "such specimens figured by d'Orbigny in the Tableau and also in the Vienna Basin Monograph have invariably an early stage consisting of biserial chambers."

As *G. laevigata* is the genotype, Cushman and Ozawa's elucidation of its structure has led Cushman (1948) to postulate initial biseriality in microspheric specimens as one of the generic features. This might appear to exclude the Thanet specimens (with triserial arrangement in the initial parts of the microspheric generation) from the genus. On the other hand, Glaessner (1945) includes the possibility of a guttulinid initial part in his generic diagnosis; though this feature is not referred to the genotype and may be included to cover such species as *Glandulina dimorphina* Bornemann, with triserial initial parts.

As the arrangement of the initial parts is such an important factor in the generic division of the polymorphinids the difference shown by the Thanet specimens from the genotype might be taken as at least worthy of specific differentiation. Cushman and Ozawa suppose *G. laevigata* to be derived from *Pyrulina* so forms with initial chambers arranged at about 140° to each other might be expected as precursors of *G. laevigata*. Against this must be set the striking similarity in shape and size and number of chambers and the possession of an initial spine. Also as will be shown later the same difficulty arises in regard to *Glandulina ovula* d'Orbigny. Therefore, until it is known whether the initial chambering is strictly biserial or sometimes less accelerated and triloculine in Miocene forms the specimens described here are referred provisionally to d'Orbigny's species.

Range.—Throughout the Tertiary of N. America and N.W. Europe.

Glandulina? ovula d'Orbigny

Plate 5, figures 3-3c

1846, *Glandulina ovula* D'ORBIGNY, Foram. Foss. du Bass. Tert. de Vienne, p. 29, pl. 1, figs. 4-5.

Distinguishing features.—An elongate, oval *Glandulina* in which the initial chambers are triserial in the microspheric form. The terminal chamber makes up less than half the length of the test and the overlap of the uniserial chambers covers no more than half of each of the preceeding chambers.

Description.—(Plate 5, fig. 3). Test elongate ovate, pointed at both ends, greatest width about the middle, terminal chamber making up less than half the length; chambers 6, triserial in the initial part, uniserial in the later part; sutures distinct, flush; aperture terminal with radial grooves; wall radiate; pores minute; initial end spined.

Dimensions.—Length 0.74 mm.; maximum width 0.31 mm.

Horizon.—RB5, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42555.

Alternation of generations.—At least two groups of proloculus size can be distinguished, one microspheric, with up to six chambers (of which those in the initial part are triserial) and at least one, possibly two, groups of uniserial megalospheric specimens with from three to four chambers and proloculi ranging from 0.12 mm. to 0.26 mm. in diameter.

Discussion.—Much of the discussion of the difficulty of relating Thanet specimens to *G. laevigata* applies to the case of *G. ovula*. These two forms are very closely allied and occur together both in the Septarian Clays of Pietzpuhl and in the Miocene of Baden. This

might indicate that the two groups are merely varieties within one species.

Range.—Possibly throughout the Tertiary of N.W. Europe.

Glandulina aff. **G. dimorphina** (Bornemann)

Plate 5, figures 2, 2a

See 1855, *Guttulina dimorphina* BORNEMANN, Zeit. Deutsch. Geol. Bd. 7, p. 375, pl. 17, fig. 5.

Description.—(Plate 5, fig. 2). Test elongate oval, terminal chamber making up about half the length; chambers 5, arranged triserially in the initial part, terminal chamber uniserial; sutures distinct, impressed; aperture terminal with radial grooves and short internal tube; wall radiate; pores minute.

Dimensions.—Length 0.41 mm.; maximum diameter 0.18 mm.

Horizon.—RB12, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42556.

Discussion.—Bornemann's figures of *Guttulina dimorphina* show more robust specimens than those recovered from the Thanet Beds and a triloculine initial part with the septa at a greater angle to the vertical axis. Some of the topotypes discussed by Cushman and Ozawa (1930) in their monograph are nearer to the Thanet Sands specimens in shape but are twice as large. *G. vitrea* is included in their synonymy as the possible microspheric form. It is very near to the Thanet specimen described and there is thus a possibility that we are dealing here with small microspheric representatives of Bornemann's species.

Range.—*Glandulina dimorphina* was described from the Oligocene of Germany.

Some Problematical Polymorphinidae

Approximately a score of specimens were recovered which show such a range of variation that in the absence of further specimens they do not make a reliable basis for the erection of new species or varieties. The generic position of these forms is also uncertain.

Pseudopolymorphina species A

Plate 5, figures 5-5n

Description.—(Plate 5, figs. 5, 5a). Test elongate, round in section; chambers 5, arranged in an irregular guttuline spiral, short except for the third chamber which extends back to the base, terminal chamber very short; sutures distinct, flush; aperture terminal with radial grooves; wall radiate; pores minute.

Dimensions.—Length 0.44 mm.; maximum width 0.15 mm.

Horizon.—RB1, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42557.

Discussion.—The specimens in this group show some similarity to the initial parts of *Sigmomorphina sporadica*, n. sp., but are relatively smaller and appear to be characterized by gradual shortening of the later chambers. All the specimens illustrated were recovered from the Reculver Silts at Reculver except the specimen illustrated in fig. 5e which was recovered from the upper Pegwell Marls at Pegwell. The specimens illustrated in figs. 5m and 5n may be varieties within this group or a quite distinct species.

Pseudopolymorphina species B

Plate 5, figures 6-6e

Description.—(Plate 5, figs. 6, 6a). Test elongate, tapering with broken terminal chamber; chambers 5, short except for the third chamber which extends back to the base, the two terminal chambers perfectly uniserial; sutures distinct, flush; aperture broken; wall radiate; pores minute.

Dimensions.—Length 0.62 mm.; maximum diameter 0.21 mm.

Horizon.—RB5, Reculver Silts.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42558.

Discussion.—This group would appear to illustrate the achievement of uniseriality presumably in allies of *Pseudopolymorphina* and apart from the *Glandulina* line.

Pseudopolymorphina species C

Plate 5, figures 7-7g

Description.—(Plate 5, figs. 7a, 7e). Test elongate, flask shaped, greatest width near the base; chambers 5, biserial in the initial part, the terminal chambers uniserial; sutures distinct, flush; aperture broken off; wall radiate; pores minute; ornament of longitudinal striae.

Dimensions.—Length 0.84 mm.

Horizon.—P39, Pegwell Marls.

Depository.—Brit. Mus. Nat. Hist., Cat. no. P42559.

Discussion.—The specimen illustrated in fig. 7 is bottle shaped and tapering with four chambers which gradually decrease in size. It is distinctive in that the aperture is produced and tube-like. The specimen illustrated in fig. 7c shows both second and third chambers reaching back to the base. Chambers with irregular biserial arrangement follow the uniserial chambers. The

specimens therefore appear to show polymorphinid, glandulinid and pseudopolymorphinid stages. The last chamber is short and has apparently bisected the previous foramina, producing two apertures. The specimen illustrated in fig. 7f shows an initial irregularly guttuline series followed by uniserial chambers. This form may possibly represent the microspheric generation. If this is the case the other specimens could be interpreted as accelerated megalospheric specimens with much reduced initial stages. This astonishing group thus appears to show guttuline, biserial and uniserial stages with a return to guttuline arrangement in one case.

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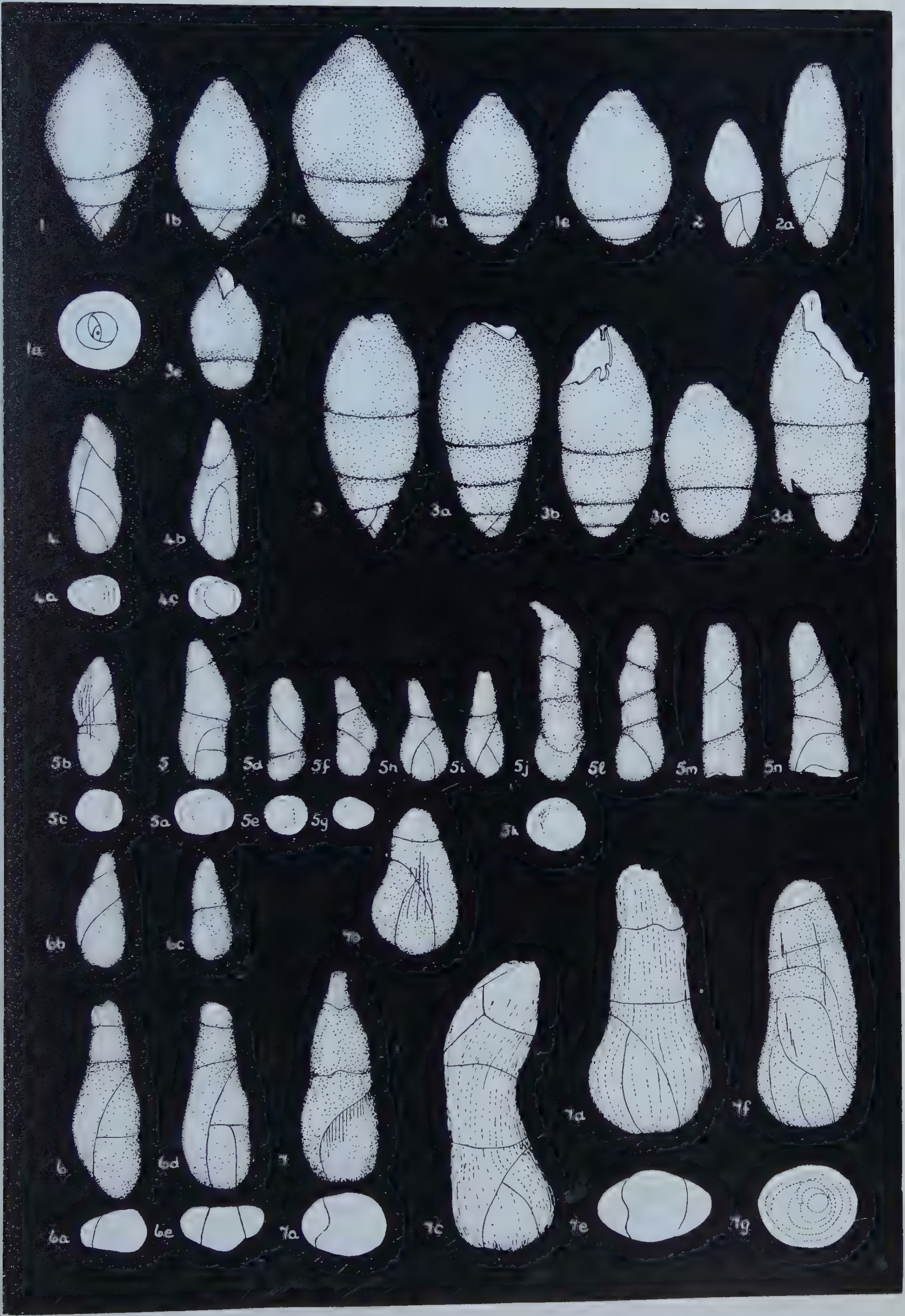
EXPLANATION OF PLATE 5

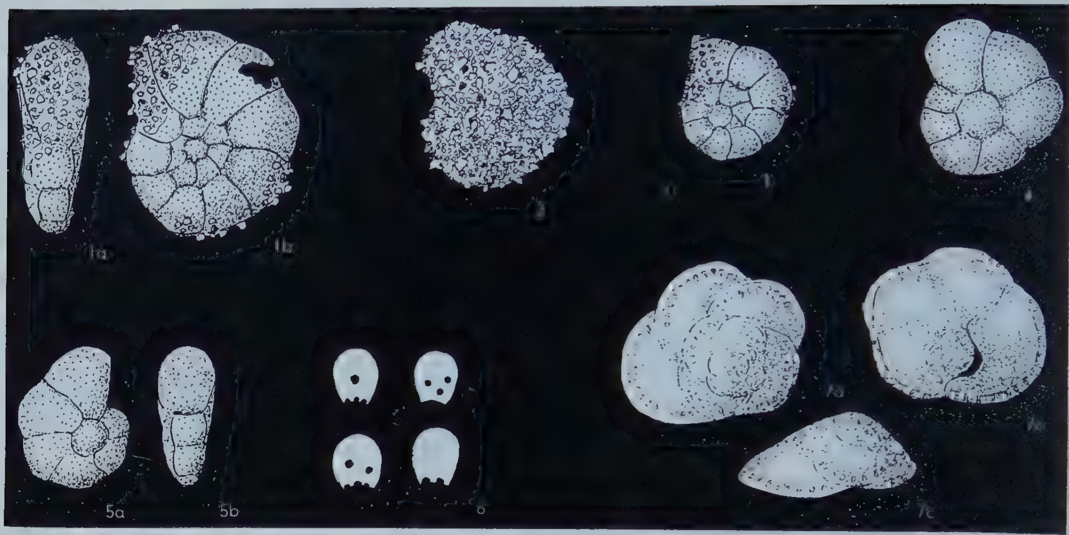
Figures 1-3, × 50; all others × 30

FIGS.		PAGE
1.	*Glandulina? laevigata* d'Orbigny; 1a, basal view; 1b-1e, megalospheric specimens	14
2.	*Glandulina* aff. *G. dimorphina* Bornemann; 2a, additional specimen	15
3.	*Glandulina? ovula* d'Orbigny; 3a, damaged microspheric specimen; 3b-3c, megalospheric specimens	14
4.	*Polymorphina eolithiformis* Haynes, n. nom. 4a, basal view; 4b and 4c, additional specimen	13
5-5n.	*Pseudopolymorphina* species A	15
6-6e.	*Pseudopolymorphina* species B	15
7-7g.	*Pseudopolymorphina* species C	15

N. B. Basal views are plan views only



Haynes: British Paleocene Foraminifera



Boltovskoy: Recent Foraminifera, Rio de la Plata, Argentina

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
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178. THE FORAMINIFERAL FAUNA OF THE RIO DE LA PLATA AND ITS RELATION TO THE CARIBBEAN AREA

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ABSTRACT

Eight foraminiferal species of which two are living (**Nonion tisburyensis** and **Trochammina ochracea**) have been found in the fresh-water Rio de la Plata. Analysis of this fauna, together with the data of other biologists, supports the conclusion that during the Miocene the Caribbean region and the Rio de la Plata were connected by a normally saline arm of the Tethys. This arm probably decreased considerably in size in the Pliocene, and possibly ceased to exist as a free passage by the end of that epoch. The origin and history of the foraminiferal fauna of the Rio de la Plata and the Argentine shelf are briefly discussed.

INTRODUCTION

In 1954 the author received from the geologists E. Chaar and J. Buscaglia, to whom he is greatly indebted, 82 bottom samples collected in the Rio de la Plata between Puerto Nuevo in Buenos Aires and the mouth of the Parana-Guazu River. The samples came from depths less than 3 m., and the stations were about 1 km. apart, at distances of 5-10 km. from the shore. The sediments of the area are mainly of a silty, sandy type, and were found to contain eight species of Foraminifera, most of them represented by only a few specimens. Despite the small number of species, however, the fauna is of considerable interest, especially from the point of view of its possible paleogeographical implications.

As would be expected, the sediment samples contained also large numbers of Thecamoebina. It is of interest to note here that considerable similarity was found between the thecamoebinian fauna of the Rio de la Plata and that described from Trinidad by Bolli and Saunders (1954).

The author has previously studied foraminiferal faunas from different parts of the Argentine continental shelf (Boltovskoy 1954 a, b, and others). Among his unpublished investigations has been a study of the fauna in the estuary of the Rio de la Plata and the zone of its influence. Thus, in studying the fauna of the samples received from Chaar and Buscaglia, it was possible to make a comparison with faunas from many parts of the continental shelf. In addition, the author has studied the collection of West Indian forms at the U. S. National Museum in Washington, D. C. All these sources of information were valuable in drawing paleogeographical conclusions and in tracing the history of the Foraminifera of the Argentine shelf, which subjects form the major parts of this paper.

THE FORAMINIFERA ENCOUNTERED

Eight species of Foraminifera were found in the material collected in the Rio de la Plata. Of these, the following six have been found previously in Argentine waters:

Alveolophragmium jeffreysii (Williamson). Only two very small but rather typical specimens were found in the material from the Rio de la Plata. It has previously been found in the estuary of the Rio de la Plata.

Trochammina ochracea (Williamson). Typical specimens, though very rare and undersized, were found in the Rio de la Plata. This species is known on the Argentine shelf from the estuary of the Rio de la Plata to the Gulf of San Jorge.

Elphidium discoidale (d'Orbigny). Also very rare and undersized in the Rio de la Plata, compared with

EXPLANATION OF PLATE 6

FIGS.		PAGE
1-6.	*Nonion tisburyensis* Butcher	18
	1. Largest specimen found (greater diam. 0.362 mm.); it was somewhat damaged but contained protoplasm. Microspheric. a, apertural view; b, side view; 2. Specimen covered with much agglutinated material; it was possible to recognize the sutures and that the specimen is megalospheric only with transmitted light. Side view; 3. Microspheric specimens with little agglutinated material. Side view; 4. Megalospheric specimen found without protoplasm, probably derived from another place since its surface has no agglutinated particles and these may have been lost; 5. Megalospheric specimen found with protoplasm and agglutinated material; the latter has been removed by the author. a, side view; b, apertural view; 6. Views showing the different positions of the openings on the apertural face.	
7.	*Asterigerinata mamilla* (Williamson). Greater diam. 0.28 mm. a, dorsal view; b, ventral view; c, side view	18

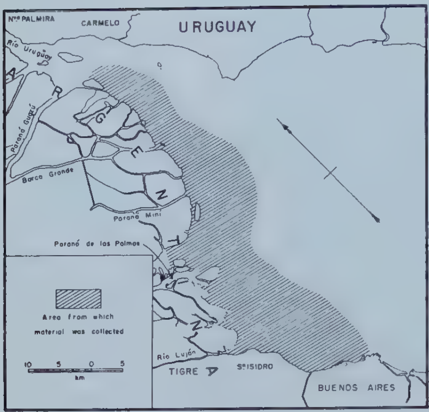

FIGURE 1
Sketch map of the western part of the Rio de la Plata.

typical specimens from the West Indies. Specimens considerably smaller than the West Indian ones occur commonly in the estuary of the Rio de la Plata, and depauperated and rare specimens have also been found southward to the Gulf of San Jorge.

Buccella frigida (Cushman). One specimen, typical but undersized, was found in the Rio de la Plata. This species is the most widely distributed of all those living on the Argentine shelf.

Rotalia beccarii parkinsoniana (d'Orbigny). A few undersized specimens. This typical West Indian species is common in the mouth of the Rio de la Plata, where the individuals are smaller than in West Indian waters but much better developed than those found in the vicinity of Buenos Aires.

Epistominella exigua (H. B. Brady). A single, very small but typical specimen was found in the Rio de la Plata. This species is distributed over the whole Argentine shelf.

The following two species, found in the material from the Rio de la Plata, are recorded from Argentine waters for the first time:

Asterigerinata mamilla (Williamson). One single, rather small but typical specimen in an excellent state of preservation (pl. 6, fig. 7).

Nonion tisburyensis Butcher. Since this species has been found in considerably greater quantity than the others and the specimens show some differences from the holotype, it is of interest to give its synonymy, description and figures.

Nonion tisburyensis Butcher

Plate 6, figures 1-6

1948. *Nonion tisburyensis* Butcher, Contr. Cushman Lab. Foram. Res., vol. 24, p. 21, text figs. 1-3.

1955. *Nonion tisburyensis* Butcher. Ronai, Contr. Cushman Found. Foram. Res., vol. 6, pt. 4, p. 145, pl. 21, figs. 3a, b.

Description.—Test calcareous, planispiral, nearly circular viewed from the side, usually symmetrical, but some slightly asymmetrical specimens also encountered. The calcareous tests are covered with varying quantities of agglutinated sand grains and other particles, which frequently obscure the chambers and sutures. Periphery rounded, in side view slightly lobulated. The last-formed whorl consists of 6-9 chambers which are somewhat inflated and the sutures are correspondingly depressed, not limbate. Wall very thin, smooth, distinctly perforate. Umbilical regions depressed. Aperture consists of a small number of very small openings situated on the apertural face, some at the base of the chamber and some at a distance from it (fig. 6). In some specimens it was impossible to find these openings. The greatest diameter 0.20-0.36 mm.

Observations.—As can be seen from the figures, both microspheric (figs. 1, 3) and megalospheric (figs. 4, 5) specimens occur. The described specimens differ from the holotype chiefly in the character of the aperture. That of the holotype as described by Butcher is "- - - a narrow arched slit at the base of the apertural face." In our specimens it is divided and irregular. Ronai (1955) described his specimens of *N. tisburyensis* as having divided apertures. The author wishes to state here that contrary to the generally accepted view he does not believe that the aperture is a stable feature in all genera, or even species, and may at times vary with a change of ecological conditions. In a previous paper (Boltovskoy 1954 a, p. 277) he expressed this idea as applied to the aperture of *Elphidium*. The modification of the aperture in a brackish-water medium has also been shown by Bartenstein and Brand (1938). Therefore, the author is of the opinion that in this case the difference in the aperture is not of importance.

The other differences between the described specimens and the holotype are: smaller size, tendency to uncoil and be asymmetrical, slightly greater diameter of the perforations, and the irregular layer of agglutinated material which partly (or sometimes entirely, see fig. 2) covers the test. All these features should be considered as the result of the ecological conditions, which will be discussed in greater detail later.

N. tisburyensis was first described by Butcher from brackish water in the tidal ponds of Cape Cod, Massachusetts. Said (1951) reported it from Narragansett Bay, Rhode Island, and Ronai (1955) from bays and lagoons of low salinity in the New York Bight. It is a typical brackish-water species.

COMPARISON AND ANALYSIS OF THE FAUNA

From the above discussion it is obvious that the foraminiferal assemblage found in the Rio de la Plata is characterized by dwarfing, poor development and scantiness, as might be expected in such a fresh-water environment. The hydrological conditions of this region are little known, but the water is undoubtedly fresh according to the classification of Hiltermann (1949). Kyle (1874) gave a salinity of 0.09 o/oo for water from the mouth of the Parana-Guazu River, and the salinity near Buenos Aires varies from 0.1 to 0.15 o/oo ("Memorias de Obras Sanitarias de la Nación," unpublished report).

It might be thought that some of the abovementioned Foraminifera could not live in water of this type, and that their presence could be due to reworking from sediments of the so-called Quaternary transgressions. The fact that the majority of the specimens have been found in the southern half of the area might support this explanation since the sediment of this part is supplied mainly by the Parana, not the Uruguay River, and Quaternary deposits are known only in the basin of the former (A. Castellanos, 1952). In fact, many specimens very probably are reworked. Nevertheless, the excellent state of preservation of some of the tests, as well as other considerations, indicate that this is not true of all the specimens. To verify this point, 21 additional samples were collected in the vicinity of Buenos Aires and the mouth of the Lujan River, and preserved in formalin. This new material contained rare tests of *Alveolophragmium jeffreysii, Elphidium discoidale, Trochammina ochracea,* and more frequent ones of *Nonion tisburyensis*: treatment with rose Bengal (method of Walton, 1952) confirmed that the last two species were alive when collected. The fact that no living examples of the other species were found is probably due to limitations of sampling and the meagreness of the foraminiferal fauna.

How does it happen that these Foraminifera now live in fresh water? Although they belong to species which can support a marked lowering of salinity, the normal condition of their existence is saline or brackish, not fluvial. The assumption that these species "conquered" fresh water in moving from east to west seems highly improbable, especially in the case of *Nonion tisburyensis;* neither this species, nor any form from which it might have been derived, was found in the estuary of the Rio de la Plata or on the Argentine shelf.

It is also difficult to explain the occurrence in the Rio de la Plata region of the three species characteristic of the cooler waters of the North Atlantic: *Alveolophragmium jeffreysii, Trochammina ochracea* and *Asterigerinata mamilla.* Even if these species (except *T. ochracea*) do not at present live near Buenos Aires, and owe their presence in the sediment to reworking, the question still remains of how they were introduced into this region. If they migrated southward along the coast of Brazil, one might expect them to be widely distributed there. But none of these species has been recorded by workers on the Recent Brazilian Foraminifera (Brady, Parker and Jones, 1888; Cushman and Parker, 1931; Carvalho and Chermont, 1952; Medeiros Tinoco, 1955).

It therefore appears that most of the Recent fauna of the Rio de la Plata migrated south by some route other than that along the Brazilian coast, and this route may have been the arm of the Tethys whose remains are now seen in the Parana River. This Tethys arm could also have been the migration route for other species found abundantly in Argentine waters and widely distributed north of South America, but hitherto unknown along the Brazilian coast, e.g. *Globulina caribaea* d'Orbigny, *Discorbis williamsoni* (Chapman and Parr) and some others.

The first to propose the existence of such an arm of the Tethys, and to give a scientific basis for it, was H. Ihering (1927, and earlier articles), who based his conclusions on a comparison of the Patagonian fauna and flora with those of Australia and New Zealand, and the

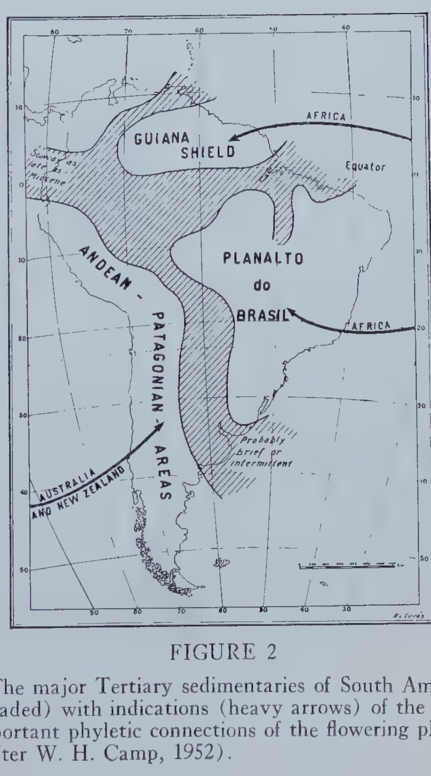

FIGURE 2

The major Tertiary sedimentaries of South America (shaded) with indications (heavy arrows) of the more important phyletic connections of the flowering plants. (After W. H. Camp, 1952).

Brazilian fauna and flora with those of Africa. H. Camp (1952) independently reached conclusions similar to those of Ihering, dividing the South American continent into three parts during the Tertiary on botanical and geological grounds. L. Szidat (1955), as a result of a study of fish and their parasites, drew the same conclusion concerning the existence of a Miocene sea separating Archiplata from Archibrasil (or, in the terminology of Camp, the Andean-Patagonian region from Planalto do Brasil). J. Frenguelli (1923, 1928) noted the presence of brackish-water and marine diatoms in continental fresh waters of the Argentine, including the Rio Primero in the province of Cordoba, but he did not suggest the possible existence of the Tethys arm.

CONCLUSION

On the basis of our present knowledge, the following appears to be a probable sequence of events:

In the Miocene the South American continent was divided by a very broad strait which ran meridionally and represented an arm of the Tethys. This arm had a normal salinity, and many species from the Gulf of Mexico and the Caribbean passed through it, some migrating farther into the South Atlantic. Ihering (1927) believed that the temperature of the sea near the Patagonian coast was considerably warmer (18°-22°C) in the Miocene than at the present time, which might favor the distribution of these species. Species typical of the cooler waters of the Atlantic could not penetrate the arm at that time because of the high temperature of the equatorial portion.

In the Pliocene the Tethys arm decreased in size considerably, and its salinity was lowered by rivers originating in the mountains of the Andean-Patagonian continent. Thus brackish-water forms, among them *Nonion tisburyensis,* could enter the arm. At the close of the Pliocene, as the first ice age began, the temperature of the water decreased and conditions were favorable for the introduction of cooler-water species. As the Tethys arm became reduced to a series of fresh-water rivers and lakes, which were in all probability interconnected, the thecamoebinian fauna from the West Indies may have been introduced into the Rio de la Plata.

The foraminiferal species which migrated southward through the late Tertiary Tethys arm had either to adapt themselves to the new hydrological conditions of the changing environment or to become extinct, unless they were able to continue their migration northward or southward along the South American coast to suitable environments. *Nonion tisburyensis* and *Trochammina ochracea* are apparently among those which adapted themselves to the fresh water; others, hitherto undetected, may have produced races adapted to fresh water.

In the middle (or upper) Pleistocene the land connection between South America and the Antarctic, which had existed for a long time, disappeared and cold water could then invade the Patagonian shelf as the Malvine (or Falkland) Current. The altered environmental conditions, including lowered temperature, may have resulted in some of the West Indian species changing to such a degree that they should now be considered as subspecies, e.g. *Nonion grateloupi punctulatum* Boltovskoy (1954 a) and *Nonion morenoi ameghinoi* Boltovskoy (1954 b). Along the coast the species could migrate farther into the Atlantic, and it is logical to suppose that the West Indian forms could advantageously migrate northward while the species characteristic of cooler water would find better conditions to the south. Such a migration may explain the striking similarity between the foraminiferal fauna of the Malvine (Falkland) Islands and that of the British Isles (Heron-Allen and Earland, 1932, p. 296).

In summary, it may be stated that evidence from the distribution of the Foraminifera supports the postulation of the existence of a strait connecting the Caribbean area with the Rio de la Plata during the Miocene. Its existence as a true strait probably terminated in the Pleistocene. Many species of the Recent fauna of the Rio de la Plata apparently entered thereby. A free passage along the Brazilian coast also existed at the same time, but the presence of some typical West Indian forms in the estuary of the Rio de la Plata and their absence (as far as our present knowledge goes) in Brazilian waters indicate that it may not have been advantageous for the migration of all forms, and that some preferred to pass through the Tethys arm.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME IX, PART 1, JANUARY, 1958

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the Foraminifera that have come to hand.

ADAMS, G. C. A study of the morphology and variation of some Upper Lias Foraminifera.—Micropaleontology, v. 3, no. 3, July 1957, p. 205-226, text figs. 1-26. —Detailed descriptions and illustrations of 3 genera, 4 species (1 new), and 3 varieties (2 new) in the Lagenidae, from core material from Lincolnshire, England.

AKERS, W. H., and HOLCK, A. J. J. Pleistocene beds near the edge of the Continental Shelf, southeastern Louisiana.—Bull. Geol. Soc. Amer., v. 68, no. 8, August 1957, p. 983-992, pls. 1, 2 (cross sections), text figs. 1-3.—Alternations of three ecologic and depth zones, based on Foraminifera, are observed in cores penetrating a maximum of about 4200 feet of marine Pleistocene.

ALLAN, R. S. Report of the standing committee on datum-planes in the geological history of the Pacific region. Symposium on geologic history, paleontology, and stratigraphy of the Pacific Basin.—Proc. 8th Pac. Sci. Congress, 1953, v. 2 (Geol. and Geophysics), 1956, p. 325-423, tables 1, 2.

ANSARY, S. E. The probable depth of the upper Eocene sea in Egypt as indicated by Foraminifera.—Bull. Instit. Desert Egypte, tome 6, no. 1, Jan. 1956, p. 193-207, map, columnar sections, 3 charts.—Basing interpretations on modern occurrence records of families and genera, the beginning of upper Eocene deposition was in deep cool waters, later becoming shallow and warm.

ANSARY, S. E., and ISMAIL, M. M. The determination of the middle-upper Eocene boundary in the area east of Helwan as indicated by Foraminifera.—Bull. Instit. Desert Egypte, tome 6, no. 1, Jan. 1956, p. 185-192, charts I-III.—Numerous species listed and occurrences compared with other Egyptian records.

ATHEARN, WILLIAM D. Comparison of clay from the continental shelf off Long Island with the Gardiners clay.—Journ. Geol., v. 65, no. 4, July 1957, p. 448, 449.—A few Foraminifera from 70-foot submarine boring taken from a Texas Tower site indicate probable presence of the Pleistocene Gardiners clay.

AVILOV, I. K. Moshchnost' Sovremennykh Osadkov I Poslednikovaja Istorija Belogo Morja.—Moscow Gosudarst. Okeanograf. Inst., Trudy, vyp. 31 (43), 1956, p. 5-57, text figs. 1-14, tables.—Includes quantitative analysis of Recent material.

BANDY, ORVILLE L., and ARNAL, ROBERT E. Distribution of Recent Foraminifera off west coast of Central America.—Am. Assoc. Petroleum Geologists Bull., v. 41, no. 9, Sept. 1957, p. 2037-2053, text figs. 1-3, tables 1-3.—Five faunal zones, based on Foraminifera, recognized from shore out to a depth of 6270 feet. Quantitative data on numerous species are included.

BARTENSTEIN, HELMUT, BETTENSTAEDT, FRANZ, and BOLLI, HANS M. Die Foraminiferen der Unterkreide von Trinidad, B.W.I. Erster Teil: Cuche- und Toco-Formation.—Eclogae Geol. Helvetiae, v. 50, no. 1, 1957, p. 5-68, pls. 1-8, text figs. 1-3 (maps, section).—Ninety species, subspecies, and indeterminate forms (with 8 species and 1 subspecies new) are described and illustrated from the Cuche and Toco formations, both of Barremian age. Age of the formations and their correlation with northwestern Germany is based upon certain benthonic Foraminifera.

BETTENSTAEDT, FRANZ, and DIETZ, CURT. Tektonische und erdölgeologische Untersuchungen im Raum Lehrte ötslich Hannover.—Geol. Jahrb., Band 74, July 1957, p. 463-521, text figs. 1-8, table 1.—Cretaceous Foraminifera listed.

BUKALOVA, G. V. On a new genus of Foraminifera from Albian deposits of the north-western Caucasus (in Russian).—Doklady, Akad. Nauk SSSR, tom 114, No. 1, 1957, p. 185-188, text figs. 1, 2.—**Globivalvulinella grossheimi** gen. et sp. nov., belonging in the Trochamminidae.

CITA, M. B. Studi stratigrafici sul Terziario Subalpino Lombardo. Nota VIII. Sintesi stratigrafica della "Gonfolite."—Riv. Ital. Pal. Stratig., v. 63, no. 2, 1957, p. 79-121, pl. 5 (columnar sections), text fig. 1 (map), table 1.—Zonation is based on smaller Foraminifera. Stratigraphic ranges between lower Oligocene and middle Miocene of about 185 species are indicated in a table.

COLE, W. STORRS. Geology of Saipan, Mariana Islands. Part 3, Paleontology. Chapter I, Larger Foraminifera.—U. S. Geol. Survey Prof. Paper 280-I, Oct. 23, 1957, p. 321-360, pls. 94-118, tables 1-4.—Descriptions and illustrations of 56 species, of which 4 are new and one is given a new name. Twenty species are from the upper Eocene (Tertiary b), 33 occur in the Miocene (Tertiary e) which is divided into an upper and a lower zone, and 7 occur in the Pleistocene. Discussions of ranges and associations of the species are included.

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DAVID, LOUIS. Étude Géologique des Monts de la Haute Medjerda.—Publ. Service Carte Géol. Algérie, n.s., Bull. No. 11, 1956, p. 1-304, pls., maps, diagrams.—Includes numerous lists of Foraminifera.

VAN GINKEL, A. C. **Fusulinella brañoserae**, a new species.—Proc. Kon. Nederl. Akad. Wetenschappen, ser. B, v. 60, no. 3, 1957, p. 182-200, photomicrographs, text fig., graphs, tables.—From the Carboniferous of Spain.

GREY, ROBERTO R. Eocene in the Philippines. Symposium on geologic history, paleontology, and stratigraphy of the Pacific Basin.—Proc. 8th Pac. Sci. Congress, 1953, v. 2 (Geol. and Geophysics), 1956, p. 503-

513, map, check list, thin section photographs.—Larger Foraminifera.

HANZLIKOVA, EVA. Microbiostratigraphical investigation of the territory described and its neighbourhood (in Czech with English summary), in MATEJKA, ALOIS, and ROTH, ZDENEK, The Geology of the Magura Flysch group in the northern river basin of the Vah between Bytca and Trencín.—Rozpravy, Ustred. ustavu geol., Svazek 22, 1956, p. 207-220, 312-318, distribution and abundance table.—Lower Cretaceous (Barremian-Aptian), Upper Cretaceous (Campanian-Danian), Paleocene, and Eocene (lower and middle) formations are recognized on the basis of Foraminifera.

HORNIBROOK, N. DE B., and HARRINGTON, H. J. The status of the Wangaloan stage.—New Zealand Journ. Sci. and Tech., Sec. B, v. 38, no. 6, May 1957, p. 655-670, text figs. 1-6 (maps, diagram, columnar sections).—Many Foraminifera mentioned in discussion of the sequence from Upper Cretaceous to middle Eocene.

IORGULESCU, TEODOR T. Contributiuni la studiul micropaleontologic al Miocenului superior din Muntenia de Est (Prahova se Buzau).—Rumania Comitet. Geologic, v. 26, 1953, p. 5-222, pls. 1-9 (illustr. of Foraminifera), pls. 1-4 (map, section, distrib. table, range chart).—One hundred twenty-one species and varieties, none new, are described and many illustrated. Distribution and abundance are shown and micropaleontologic zones established.

JURKIEWICZ, HENRYK. About occurrence of Cretaceous foraminifers on secondary deposit in younger sediments of Carpathian Flysch (in Polish).—Przeglad Geol., no. 9, 1957, p. 430-431, text figs. 1-4.

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KIESEL-NASIADEK, YVONNE. Die Foraminiferen des Turons von Pirna.—Min.-Geol. Jahrb. Dresden, 1954 (1955), p. 24-58, 1 pl., 2 text figs. (section, map).—Numerous species listed, none new.

KOCHANSKY-DEVIDE, VANDA. Ubersicht der bisherigen untersuchungen der Fusuliniden von Jugoslawien (in Yugoslavian with German summary).—1st Geol. Congress of FNR Yugoslavia, Trans. & repts., Bled 23, May 27, 1954 (1956), p. 139-153, 2 tables.

LANKFORD, ROBERT R., and CURRAY, JOSEPH R. Mid-Tertiary rock outcrop on continental shelf, northwest Gulf of Mexico.—Am. Assoc. Petroleum Geologists Bull., v. 41, no. 9, Sept. 1957, p. 2113-2117, text fig. 1 (map), table 1.—A deep-water assemblage of Foraminifera, approximately equivalent to the **Globigerinatella insueta** zone, listed by H. M. BOLLI from submarine outcrops on Stetson Bank which is interpreted as a salt dome.

LANTERNO, EDOUARD, and ROVEDA, VITTORIO. Sur les couples de **Nummulites: N. incrassatus** (B) - **N. ramondiformis** (A) et **N. vascus** (B) - **N. boucheri** (A). —162me Année Arch. Sci. Phys. Nat. Genève, v. 10, fasc. 2, 1957, p. 137-170, pls. 1, 2.—New descriptions based on de la Harpe's specimens indicate the micro-megalospheric relations in two pairs of species; the first-mentioned pair being inflated and ranging from middle Eocene to Oligocene; the other pair being very flat and restricted to Oligocene.

LUDBROOK, N. H. A reference column for the Tertiary sediments of the South Australian portion of the Murray Basin.—Journ. and Proc. Roy. Soc. New South Wales, v. 90, pt. IV, 1956 (July 31, 1957), p. 174-180, table 1 (stratigraphic section).—Many Foraminifera are mentioned as characteristic of several of the formations discussed.

LUDWICK, JOHN C., and WALTON, WILLIAM R. Shelf-edge, calcareous prominences in northeastern Gulf of Mexico.—Am. Assoc. Petroleum Geologists Bull., v. 41, no. 9, Sept., 1957, p. 2054-2101, text figs. 1-19, tables 1-4.—Interpreted as a reef intermediate between active growth and fossilization. Quantitative analysis of living and dead Foraminifera.

MALZAHN, ERICH. Neue Fossilfunde und vertikale Verbreitung der niederrheinischen Zechsteinfauna in den Bohrungen Kamp 4 und Friedrich Heinrich 57 bei Kamp-Lintfort.—Geol. Jahrb., Band 73, May 1957, p. 91-126, pls. 10-13, text fig. 1, table 1.—Many Permian Foraminifera listed.

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MONCHARMONT ZEI, MARIA. Foraminiferi di un campione di fondo prelevato all'Ammontatura nel Golfo di Napoli.—Boll. Soc. Nat. Napoli, v. 65, 1956 (1957), p. 45-54, pls. 1, 2.—List and photographs of a rich fauna from a depth of 200 meters.

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MOROZOVA, V. G. The Foraminifera superfamily—Globigerinidea superfam. nova and some of its representatives (in Russian).—Doklady, Akad. Nauk SSSR, tom 114, no. 5, 1957, p. 1109-1112, text fig. 1.—Globigerinidae, Globotruncanidae fam. nov., Globorotaliidae, and Hantkeninidae are included in the new superfamily. Three new genera are proposed: **Planorotalia** (type **Planulina membranacea** Ehrenberg) in the Globigerinidae, **Planorotalites** (type **Globorotalia pseudoscitula** Glaessner) in the Globorotaliidae, and **Eohastigerinella** (type **Hastigerinella watersi**) in the Hantkeninidae; and one new species, **Acarinina praecursorius.**

OBERHAUSER, RUDOLF. Ein Vorkommen von **Trocholina** und **Paratrocholina** in der ostalpinen Trias.—Jahrb. Geol. Bundes., Jahrg. 1957, Band 100, heft 2, p. 257-267, pls. 20, 21, text fig. 1.—Five new species and subspecies of **Trocholina** and one new species of **Paratrocholina.**

OINOMIKADO, TSUNETERU. Micropaleontological investigation of subsurface samples from seismic survey shot holes in Tainan district.—Symposium on Petr. Geol. of Taiwan, April 30, 1957, p. 272-285, pls. 20-1 to 20-4 (map, section, graphs, distribution and abundance table), tables 1, 2.—Correlation of Foraminifera assemblages. Numerous species listed.

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RUTH TODD

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